DRAFT ENVIRONMENTAL STATEMENT

PROPOSED MINING AND RECLAMATION PLAN

SPRING CREEK MINE

Big Horn County, Montana

United States Department of the Interior

GEOLOGICAL SURVEY

Enclosed for your review and comment is the draft environmental impact statement concerning the proposed plan of mining and reclamation, Spring Creek mine, Northern Energy Resources Company, Federal coal lease M 069782, Northern Powder River Coal Basin. DES 78-30 was transmitted to the Council on Environmental Quality and the Montana Environmental Quality Council on August 11, 1978.

The Director, U.S. Geological Survey, National Center, Mail Stop 108, Reston, Virginia 22092, will receive any written comments you may wish to make until the close of business on October 13, 1978. All comments received by that date will be carefully considered in our preparation of the final statement.

Public hearings on this draft will be held on September 20, 1978 at the Big Horn County Shop in Decker, Montana and on September 21, 1978 at the Sheridan Center Motor Inn, Main Street, Sheridan, Wyoming. Hearings will begin at 1:00 p.m. and 7:00 p.m. and will continue until all present, who desire, have spoken.

Questions concerning the draft statement should be directed to either Glenn Malmberg, Federal Task Force Leader, U.S. Geological Survey, P. O. Box 1135, Billings, Montana 59103 (phone 406-657-6678) or to Craig Howard, Spring Creek Coordinator, Department of State Lands, 1625 11th Ave., Helena, Montana 59601 (phone 406-449-2074).

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

U.S. DEPARTMENT OF THE INTERIOR

MONTANA DEPARTMENT OF STATE LANDS

DRAFT
ENVIRONMENTAL STATEMENT

PROPOSED MINING AND RECLAMATION PLAN
SPRING CREEK MINE
SPRING CREEK COAL COMPANY

(A subsidiary of Northern Energy Resources Company, Inc.)

BIG HORN COUNTY, MONTANA

Prepared by

U.S. Geological Survey, Department of the Interior

Montana Department of State Lands

Leo Berry, Jr., Commissioner
Montana Department of State Lands

H. William Menard, Director
U.S. Geological Survey

SUMMARY

(X) Draft ( ) Final Environmental Statement

Department of the Interior, U.S. Geological Survey

Montana Department of State Lands

1. Type of action: (X) Administrative ( ) Legislative

2. Brief description of action

State and Federal actions involve either approval or denial of permits for the proposed surface mining and reclamation plan, Spring Creek mine, Big Horn County, Montana, submitted by the Spring Creek Coal Company. The company proposes to open a new mine, complete with plant, loading facilities, haul and access roads, and railroad spur, extending northwestward from the Decker mine. An estimated 243 million tons of low-sulfur coal would be removed from an area of about 1,850 acres within the 4,420-acre permit area over a period of about 25 years.

3. Summary of adverse, unavoidable environmental impacts

A. The low range of hills in the mine area would be replaced by a broad, gently-sloping plain. Shallow aquifers and other stratigraphic beds would be destroyed within the mine area and replaced with an admixture of unconsolidated overburden material devoid of its original texture, permeability, and structure.

B. Local ground-water quality would be lowered by leaching of magnesium sulfate from the reclaimed spoils. The water table would be lowered to the east of the permit area possibly causing one well to become unusable.

C. Soils would be removed, mixed, altered and replaced on the mine areas causing a reduction in soil structure & diversity, infiltration, hydraulic conductivity and moisture holding capacity and an increase in bulk density, alkalinity, and soluble salts. Disturbed areas would experience unavoidable long-term loss of productivity until complete rehabilitation is accomplished.

D. Mining, coal-processing, and coal-transport operations would cause short-term localized reduction in ambient air quality. Scenic views and open-space qualities would be locally degraded until reclamation is completed.

E. Increased vehicular and train traffic will periodically cause congestion, increased noise, dust and gaseous pollution, road maintenance and accidents.

F. Long-term rearrangement would occur in the size, area, and location of vegetation community types. The loss of vegetation diversity and replacement of shruby species by grasses would decrease the carrying capacity for livestock and wildlife. Approximately 4,400 acres of grazing land would be unuseable until reclamation is completed.

G. The existing diverse habitat would be destroyed and replaced by topographic features and plant species not generally suitable for deer, antelope and sage grouse and other species currently inhabiting the area. The impacts probably will be long-term. Game birds and animals would be displaced and the population of songbirds, rodents and reptiles would decrease. Human activity associated with the mining operations would also impose adverse short-term impacts on wildlife.

H. In-migration of employee population to the Birney-Sheridan area would adversely affect the quality of life of those living in the area. This would occur through subtle as well as acute impingements on both social and psychological well-being of individuals, social disorganization.

4. Alternatives considered

A. Administrative alternatives available to the Secretary of the Interior.

B. Administrative alternatives available to State Agencies.

C. Technologic alternatives available to Federal and State authorities.

D. Technical alternatives proposed by the company.

E. Alternate mining plan - Central Field Mine Plan

F. Alternate mitigation measures

Summary Attachment:

Comments were requested from the following:

Federal agencies

- Department of Agriculture
- Soil Conservation Service
- Department of Energy
- Department of Health, Education, and Welfare
- Department of Housing and Urban Development
- Department of the Interior
    - Bureau of Indian Affairs
    - Bureau of Land Management
    - Bureau of Mines
    - Bureau of Reclamation
    - Fish and Wildlife Service
    - Heritage Conservation and Recreation Service
    - Office of Surface Mining
- Department of Labor
- Mining Safety and Health Administration
- Department of Transportation
- Environmental Protection Agency
- Federal Energy Regulatory Commission
- Interstate Commerce Commission
- President's Advisory Council on Historic Preservation

State and local agencies

- Office of the Governor, Montana
- Office of the Governor, Wyoming
- Montana Agricultural Experiment Station
- Montana Department of Community Affairs
- Montana Department of Revenue
- Montana Energy Advisory Council
- Montana Environmental Quality Council
- Montana State Historic Preservation Officer
- Montana Department of Fish and Game
- Montana Department of Health and Environmental Sciences
- Montana Bureau of Mines and Geology
- Montana Department of Natural Resources and Conservation
- Board of County Commissioners, Big Horn County, Montana
- Board of County Commissioners, Rosebud County, Montana
- Board of County Commissioners, Sheridan County, Wyoming
- Mayor, City of Sheridan

Applicant

- Spring Creek Coal Company

ENGLISH-METRIC CONVERSION FACTORS

To convert English unit	Multiply by	To obtain Metric unit
Inches (in)--------------	2.54	Centimeters (cm).
Feet (ft)----------------	3.048×10^{1}	Centimeters (cm).
	3.048×10^{-1}	Meters (m).
Miles (mi)---------------	1.609	Kilometers (km).
Square feet (ft^2)--------	9.290×10^{-2}	Square meters (m^2).
Acres--------------------	4.047×10^{-1}	Hectares (ha).
	4.047×10^{-3}	Square Kilometers (km^2).
Acre-feet (acre-ft)------	1.233×10^{3}	Cubic meters (m^3).
	1.233×10^{-3}	Cubic hectometers (hm^3).
Cubic yards (yd^3)--------	7.646×10^{-1}	Cubic meters (m^3).
Pounds (lb)--------------	4.536×10^{-1}	Kilograms (kg).
Short tons (tons)--------	9.072×10^{-1}	Metric tons (t).
Pounds per acre (lb/acre)	4.883	Kilograms per hectare (kg/ha).
Btu/lb-------------------	2.326	Kilojoules per kilogram (kJ/kg).
Gallons (gal)------------	3.785×10^{-3}	Cubic meters (m^3).
Gallons per minute (gal/min)--------------	6.309×10^{-2}	Liters per second (L/s).
Degrees Fahrenheit (°F)--	([1])	Degrees Celsius (°C).

[1]Temperature in °C =(temperature in °F-32)/1.8.

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CHAPTER I: DESCRIPTION OF THE PROPOSED ACTIONS

A. FEDERAL, STATE, AND COUNTY ACTIONS

Several interrelated federal, state, and county actions are involved in the approval or denial of applications for permits, stemming from a proposal by Spring Creek Coal Company, to open a new coal mine in Big Horn County, Montana. To operate this proposed mine, Spring Creek Coal Co. must obtain both Federal and State surface mining and reclamation permits, in addition to other permits required for associated activities. Table I-1 shows these various activities and the respective administrative governmental agencies.

B. BACKGROUND AND HISTORY

In April 1976, the Secretary of the Interior directed the preparation of a regional impact statement covering proposed development on existing Federal coal leases in the Montana portion of the Powder River Basin, including all or parts of Custer, Rosebud, Treasure, Big Horn and Powder River Counties, Montana.

A number of the coal-related actions in Montana are simultaneously pending before both Federal and State agencies, and the requirements of the Montana Environmental Policy Act (MEPA) are essentially the same as those of the National Environmental Policy Act (NEPA). Thus later in 1976, the State and the Geological Survey, as lead Federal agency agreed to prepare the regional environmental statement jointly and thus meet their individual responsibilities in a single effort. That regional statement is now expected to be published in draft form near the end of 1978.

The regional statement analyzes several possible future levels of coal development, which take into account presently approved mining operations, a number of pending proposed mines, development of existing undeveloped Federal and State coal leases and privately-owned coal resources. In addition, it includes action on pending lease applications for Federal coal to the extent the Secretary is permitted to do so under judgements rendered in the case of NRDC vs. Hughes (Civil Action No. 75-1749, U.S. District Court for the District of Columbia). In its evaluation of cumulative impacts of coal development in the region, the regional statement specifically includes the impacts that would be generated by Spring Creek mine, should it be approved.

Under Montana's mining and reclamation laws, that State must render its decision on mining permit applications within an absolute maximum of 240 days after acceptance of the application. The application for the Spring Creek mine was submitted in August 1977. In order to accomplish the MEPA process and requirements and meet the statutory time constraints, and because the joint regional statement could not be concluded within that time-frame, the State and Federal agencies have proceeded to prepare this site-specific impact statement on the Spring Creek mine as a separate and concurrent joint effort.

TABLE I-1.--Permit requirements and authorizing Federal, State, and local governmental agencies

Permit	Agency
Surface mining and reclamation	Office of Surface Mining U.S. Geological Survey Montana Department of State Lands
Rights-of-way for railroad, highway, powerline, and access road	Bureau of Land Management Montana Department of Natural Resources & Conservation Montana Department of Highways Big Horn County, Montana
Stream bed construction and runoff retention	Army Corps of Engineers Montana Department of Health & Environmental Sciences Montana Department of Natural Resources & Conservation Big Horn Conservation District
Sewage, solid waste, and temporary oily waste disposal	Montana Department of Health & Environmental Sciences Big Horn County, Montana
Explosives manufacturing and storage	U.S. Treasury
Water supplies	Montana Department of Health & Environmental Sciences Montana Department of Naural Resources & Conservation
Building Construction and Housing	Montana Department of Administration Montana Department of Community Affairs Montana Department of Health & Environmental Sciences Big Horn County, Montana
Air Quality Emissions	Environmental Protection Agency Montana Department of Health & Environmental Sciences
High structures (Radio Tower and Coal Storage Building)	Federal Aviation Administration
Radio Transmission	Federal Communication Commission

The mining and reclamation plans described in this statement were prepared on the basis of information and maps furnished by Spring Creek Coal Co. to the U.S. Geological Survey and the Montana Department of State Lands for a new coal mining operation proposed on U.S. BLM Lease Montana-069782 in Big Horn County, Montana. The proposed plans are intended to comply with pertinent federal, state, and county laws and must comply and be approved if Spring Creek Coal Co. is to operate such a mine in Montana.

The mining and reclamation plan included in this statement was submitted for review prior to the promulgation of initial regulations (30 CFR 700) required under Sections 502 and 523 of the Surface Mining Control and Reclamation Act (SMCRA) of 1977 (Public Law 95-87) and the emergency regulations promulgated under the Montana Strip and Underground Mine Reclamation Act of 1973 (Title 50 Chapter 10, RCM 1947). The application has not been officially reviewed for compliance therewith· therefore, the company's mining and reclamation plan may not reflect the initial requirements of these regulations. However, in this statement the regulations are considered to be required Federal and State mitigating measures.

The mining and reclamation plan has been returned to the operator with a request that it be revised in accordance with the applicable regulations. In response to this request, the company submitted a preliminary modification of the mine plan in April 1978, which will be addressed in Chapter VIII. As soon as the mining and reclamation plan is officially revised and submitted to the U.S. Geological Survey and the Montana Department of State Lands, it will be evaluated in conjunction with the Office of Surface Mining (OSM) to determine compliance with the requirements of Federal and State regulations. The mining and reclamation plan will not be approved until it conforms to these requirements and all other applicable Federal and State regulations.

1. PURPOSE

Spring Creek Coal Co. proposes to mine approximately 243 million tons of the 287-million ton deposit of low-sulfur (0.75 lbs/ million Btu) subbituminous coal over a 25-year period, from an area to be known as the Spring Creek mine, encompassing a Federal coal lease of 2,347.46 acres within a Montana State permit application area of 4,420 acres. Coal from this mine would be transported by unit train to electric-power generation plants where it would be used. The company currently has a commitment to supply 5 million tons of coal per year to coal-fired plants owned by Pacific Power & Light Company (PP&L), if PP&L wishes to utilize this option. The company has a contract commitment to provide 7 million tons of coal per year to Utility Fuels Inc., a subsidiary of Houston Industries Inc. of Texas.

2. LOCATION

The proposed permit area is in Big Horn County, Montana, approximately 8 miles north of the Montana-Wyoming border (fig. I-1 and I-2).

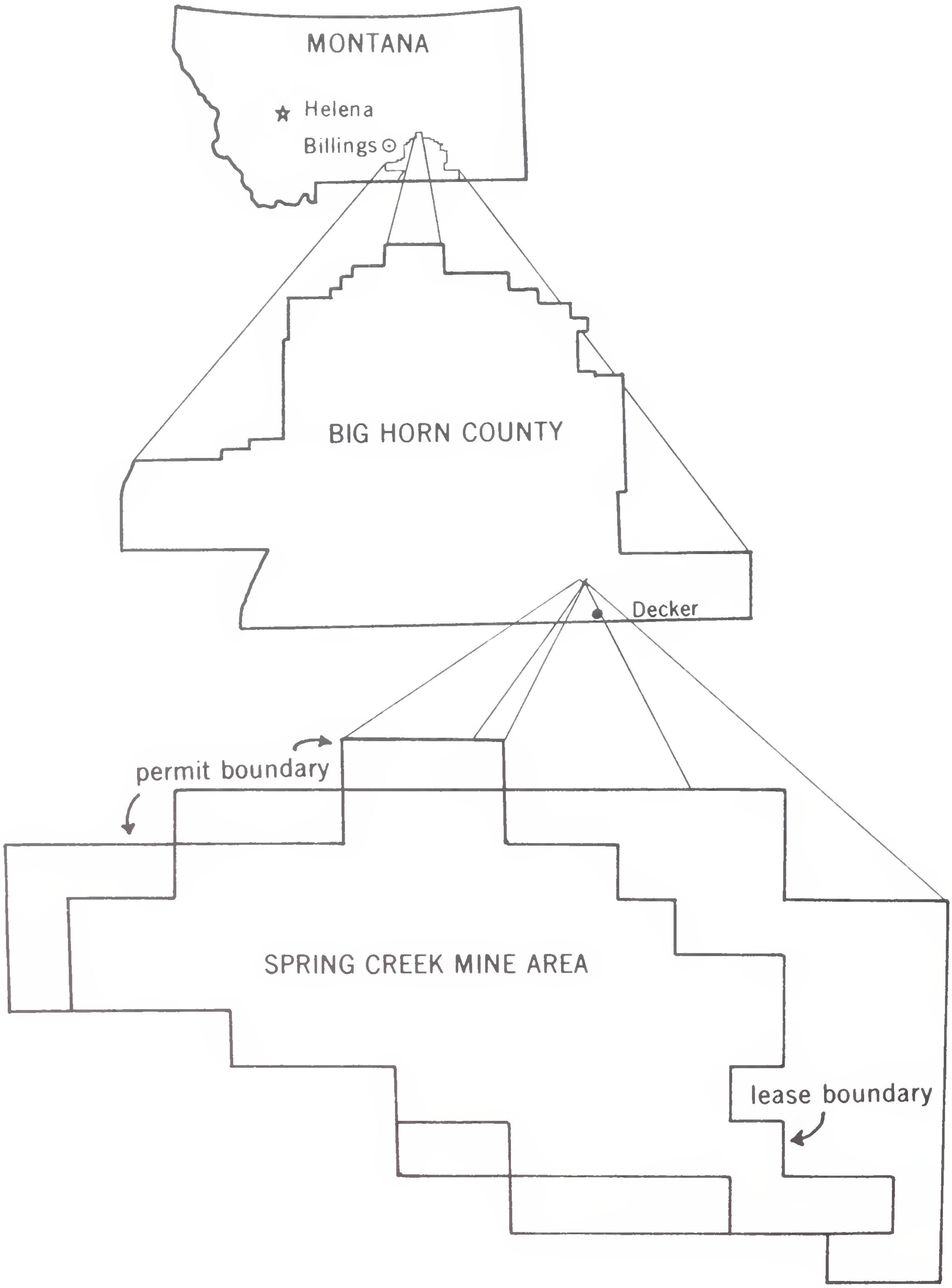

FIGURE I-1.--Index map showing the Spring Creek coal field.

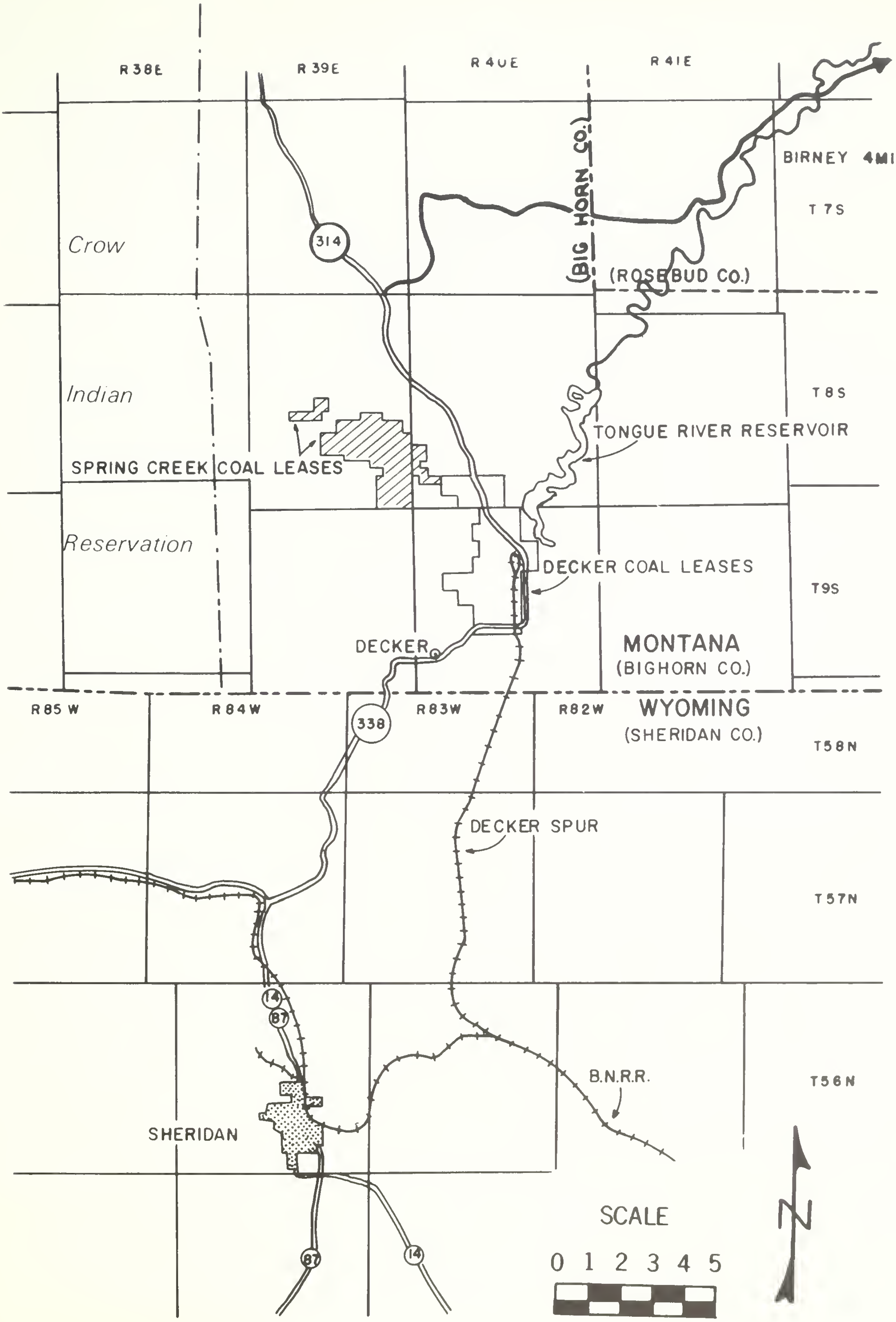

FIGURE I-2.--General location map of the Spring Creek coal leases.

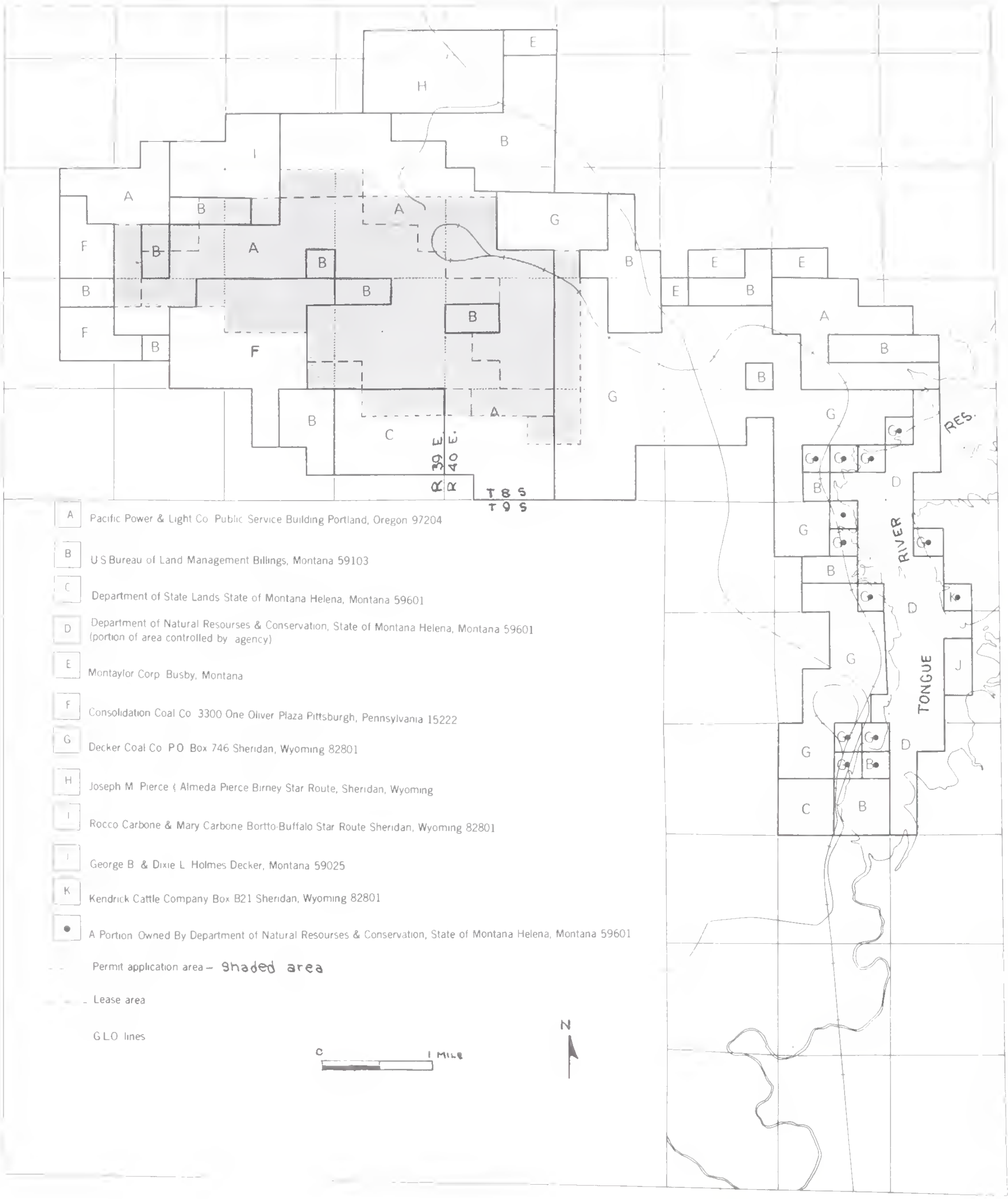

FIGURE I-3.--Map showing distribution of surface ownership.

The nearest major town is Sheridan Wyoming, 28 miles south via Montana Federal Aid Secondary (FAS) Route 314 and Wyoming Route 338; Decker, Montana is approximately 11 miles south on Montana FAS Route 314. The Tongue River Reservoir and the proposed North Extension of the West Decker Decker mine lie 4 miles east of the Spring Creek area. The West Decker mine proper lies 5 miles to the southeast. The Crow Indian Reservation boundary is about 3 miles west of the permit area, the Northern Cheyenne Reservation about 16 miles north.

3. OWNERSHIP AND USE RIGHTS

The pattern of land-surface and mineral ownership is complex within the permit area: about 320 acres of surface remain totally in federal ownership, about 120 acres in state ownership, and about 3,980 in private ownership. However, additional small parcels of State and Federal land are crossed by the proposed access road and rail-utility corridor (fig. I-3), a power line of Tongue River Electric Cooperative of Ashland, Montana intersecting the latter (fig. I-4). Telephone lines of the Range Telephone Cooperative, Inc. of Forsyth, Montana parallel FAS Route 314. If these lines are not relocated, they would be intersected at two points by the rail-utility corridor.

When lands in this general area were patented, coal was retained in Federal ownership under the entire permit area, except for the 120-acre tract in State section 36. Under those patented lands where the Federal Government reserved only coal (about half the permit area), rights to other minerals present passed to the surface owner. The present pattern of public mineral ownership in the mine area and along the transportation corridors is shown in figure I-4; the tracts where minerals other than coal are held by private individuals or companies are shown in figure I-5.

Valuable hydrocarbons other than coal (oil and gas) have been sought in this area. Between 1955 and 1968 5 dry holes were drilled along an east-west line about 1 mile to the south of the proposed Spring Creek mine. These wells were relatively shallow, the deepest reaching approximately 8,300 ft below the surface (Montana State Oil & Gas Conservation Board files, Billings). Oil and gas interest in the area is currently high; approximately 2,100 acres within the permit area are under nine Federal oil and gas leases. Four of these were issued between December 1, 1969 and October 1, 1976.

4. EXISTING COAL RESOURCE HOLDINGS, SPRING CREEK COAL CO.

The entire holdings on the Spring Creek Coal Co. in Montana consist of 3,306.27 acres of coal lands under lease in the Spring Creek area. This acreage is in three separate leases, two of which (Federal and State) are contiguous (fig. I-6). Federal lease Montana 069782, the subject of this EIS, encompasses 2,346.76 acres, and is joined to the south by Montana State coal lease C-535-65, containing 640 acres. The third, a private coal lease of 320 acres lies northwest of the other two leases and is separated from them by about 0.5 mile.

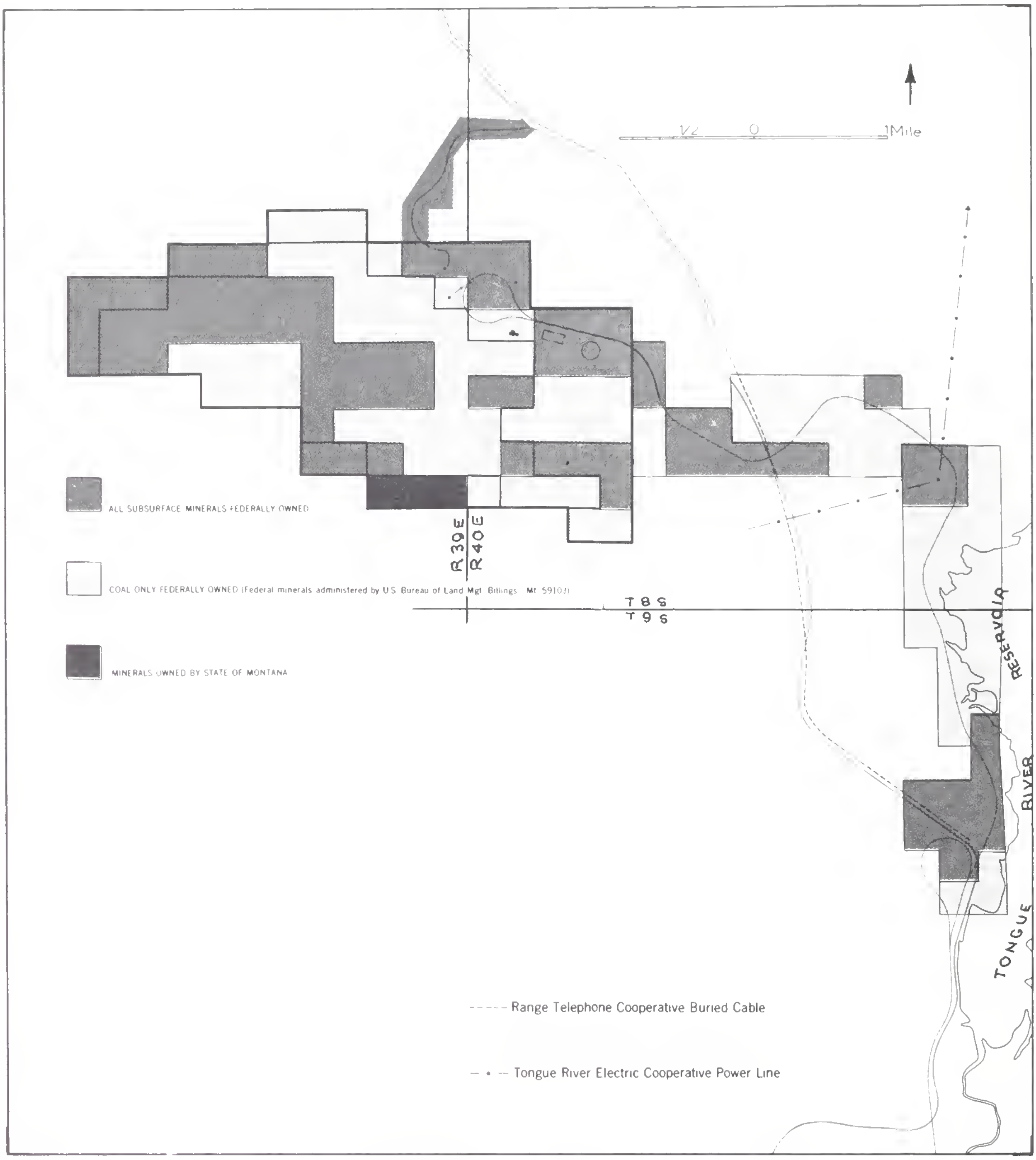

FIGURE I-4.--Public minerals ownership map.

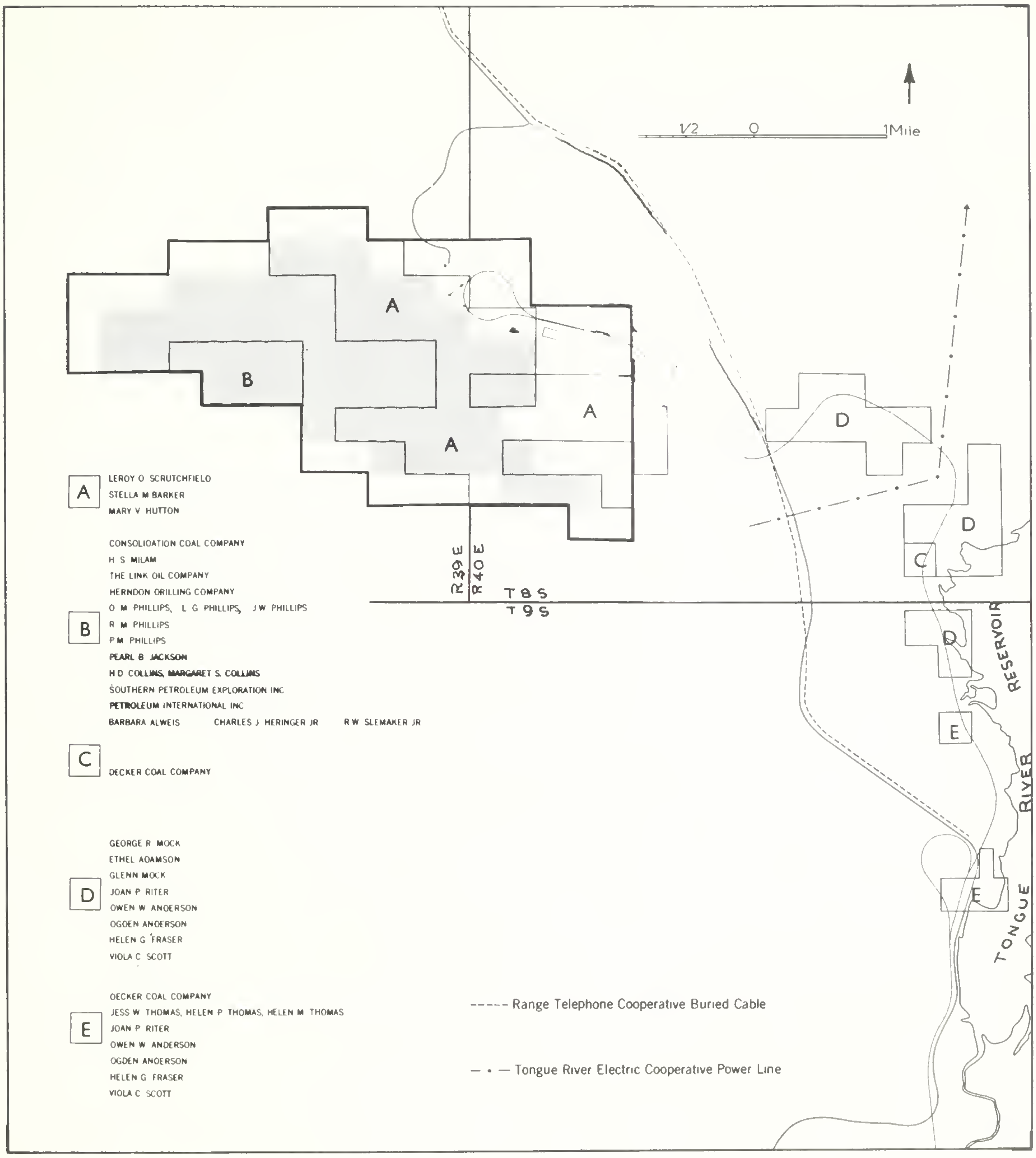

FIGURE I-5.--Private minerals ownership map.

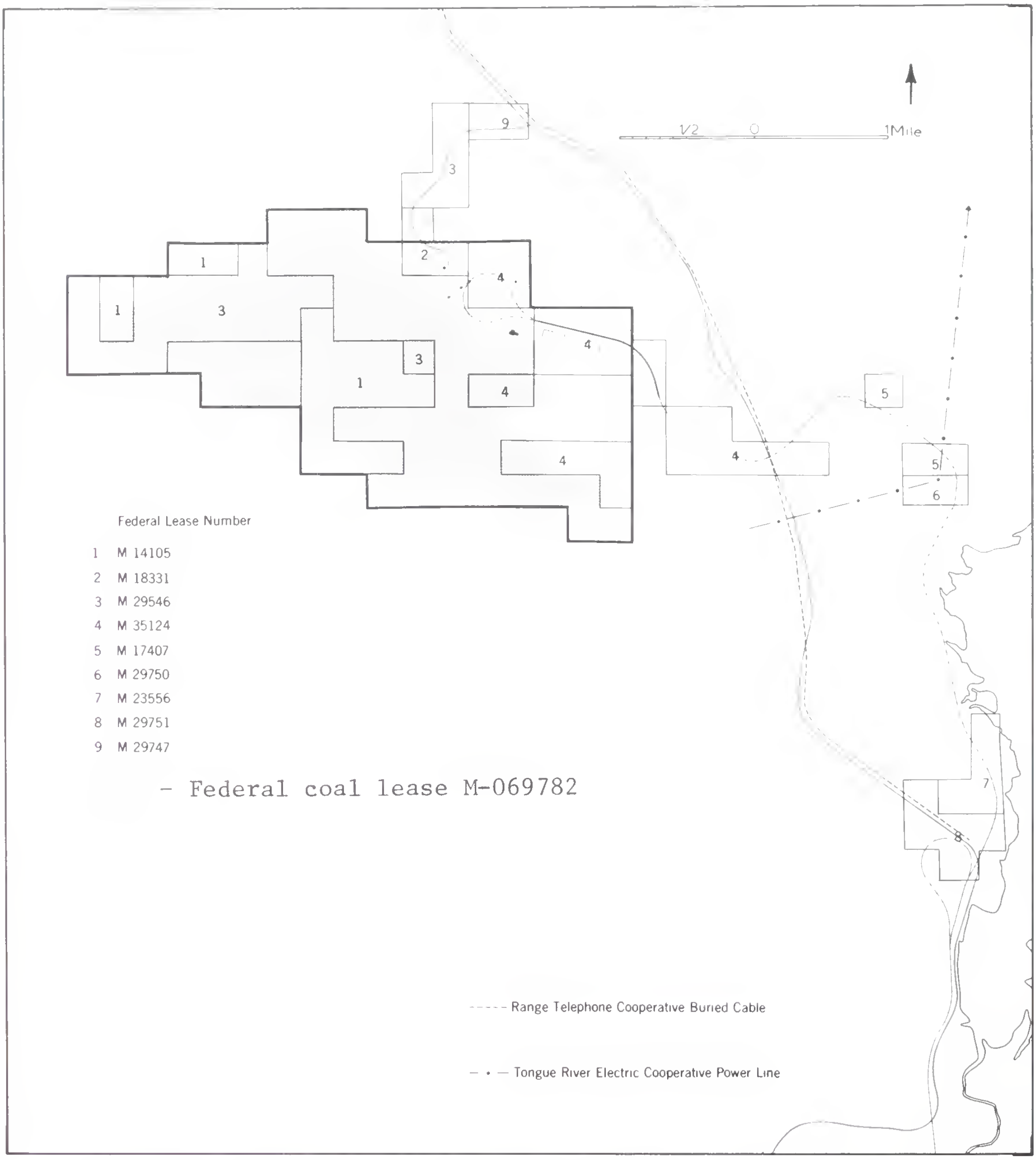

FIGURE I-6.--Federal oil and gas lease map.

Estimates based on exploration work to date indicate that about 405 million tons of reserves in the Anderson, Dietz 1 and Dietz 2 coal seams underlie lands leased by Spring Creek Coal Co. At the present time the company plans to mine only the Federal reserves. Those reserves underlying the State and private leases are considered to be uneconomical because of a greater average thickness of overburden, resulting in an unfavorable stripping ratio [1]. Also, the private lease is not contiguous with the rest of the leased area. Coal reserves are distributed among the leases as follows:

Federal Lease Montana-069782------------------	287 million tons
Montana State Lease C-535-65------------------	74 million tons
Scrutchfield Lease (private)------------------	44 million tons
Total Reserves----------	405 million tons

Federal lease Montana-069782, containing 2,504.22 acres; was issued to Peter Kiewit Sons' Co. on July 1, 1965 after a competitive sale. Peter Kiewit assigned this lease to Pacific Power & Light Co. (PP&L) on December 15, 1965. On September 1, 1966, the lease was modified to the present 2,346.76 acres.

The Federal lease, with the Bureau of Land Management, is a continuing lease subject to reasonable readjustment of terms on a 20-year basis. Under section 5 of the lease, the lessor may prescribe the steps to be taken and restoration to be made with respect to the leased lands and improvements thereon, whether or not owned by the United States. In addition to section 5, the lease contains four general requirements and 21 special stipulations covering surface reclamation and protection of the environment.

5. DESCRIPTION OF THE COAL RESOURCE

The coal deposits which underlie the Spring Creek coal field are beds in the Fort Union Formation of Tertiary age. Mine plans call for exposure and extraction of three beds of coal which are essentially a single seam averaging 81 feet in thickness. The three coal beds to be mined are (in decending order) the Anderson, Dietz 1, and Dietz 2. The Dietz 1 and 2 have merged in the mine area and are separated from the Anderson seam by a parting 1-to-18 inches thick. Figure I-7 shows the coal thickness throughout the mine area.

Coal from the proposed Spring Creek mine is considered a good fuel source for electric utilities because it would meet sulfur dioxide (SO_2) emission standards of the Environmental Protection Agency (EPA). Present EPA emission standards limit SO_2 emissions from power plants to 1.2 pounds per million Btu's fired. A comparison of relative sulfur and

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1 Cubic yards of overburden to be moved, divided by the number of tons of coal to be mined.

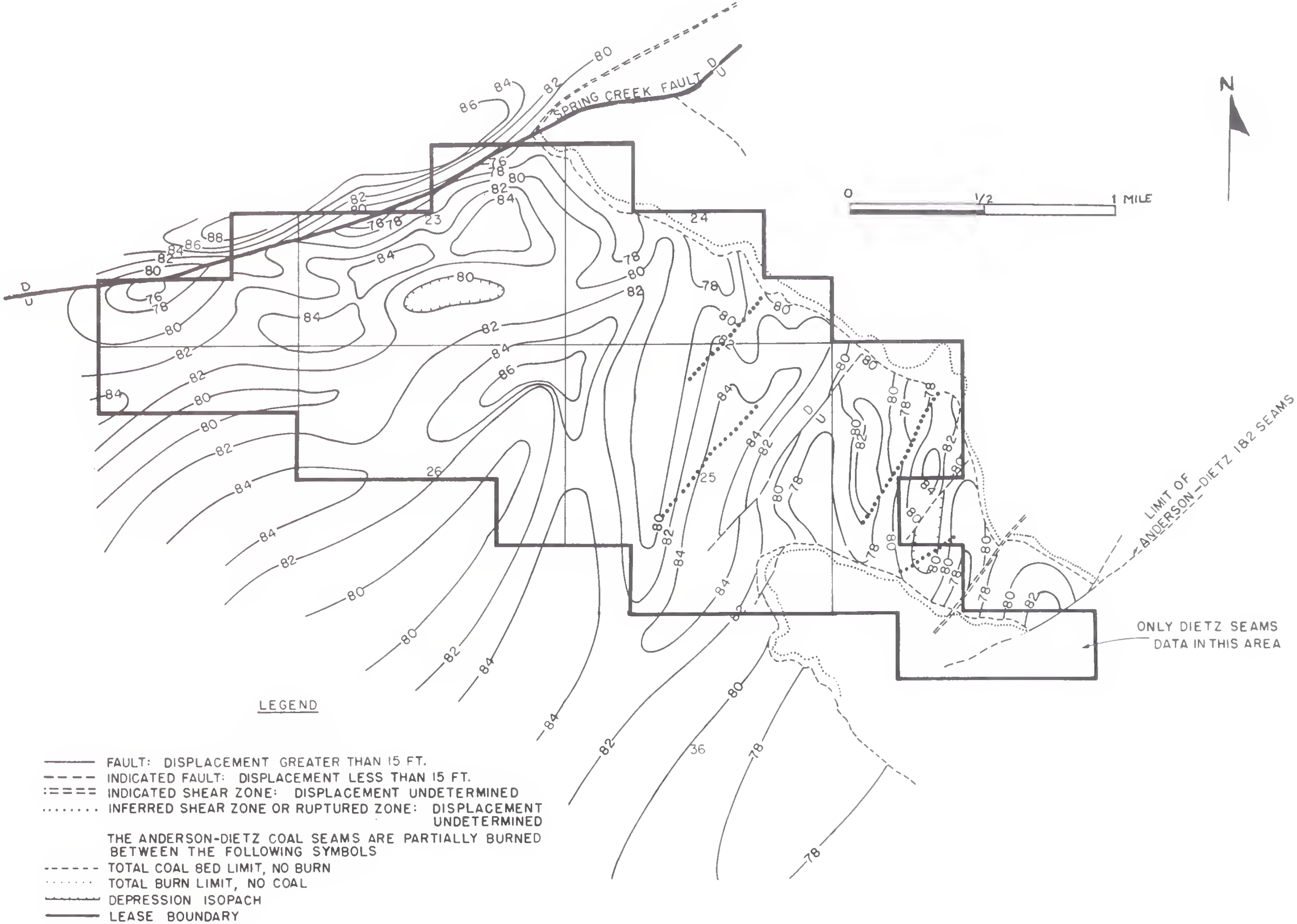


FIGURE I-7.--Isopach map of coal thickness.

heat characteristics of coal from the Spring Creek area and Illinois coal is shown in the following table:

	Btu	Sulfur (%)	SO_2 in flue gas (lbs/million Btu)
Spring Creek[1/]	9373	0.35	0.75
Illinois[2/]	11300	2.94	5.20

1/ Spring Creek average of Anderson, Dietz 1 and 2 combined seams.

2/ U.S. Bureau of Mines (1972).

An average of nine "as received" analyses of the coal physical and chemical properties is as follows:

Btu/pound--------------------	9373
% Sulfur---------------------	0.35
% Moisture-------------------	25.06
% Ash------------------------	3.56
% Volatile-------------------	32.81
% Fixed carbon---------------	38.59
% Carbon---------------------	54.22
% Equilibrium moisture-------	23.05
True specific gravity--------	1.31

Analyses of 17 trace elements from three test drill holes are presented in table I-2.

Another bed of coal, named the Canyon, lies approximately 106 feet below the base of the Dietz 2 seam. This bed is about 19 feet thick and is considered, by the company, uneconomical for mining because of its depth. The quality of the Canyon coal is nearly the same as the Anderson-Dietz coal, as indicated by an average of four "as received" analyses of the Canyon coal below:

Btu/pound--------------	9508
% Sulfur---------------	0.36
% Moisture-------------	24.29
% Ash------------------	3.66
% Volatile-------------	30.64
% Fixed carbon---------	41.47

Items of environmental concern, in considering removal of the Canyon seam include: greater disturbance of the ground water hydrology system; a larger amount of surface disturbance before reclamation; and, greater disturbance of the South Fork Spring Creek drainage system.

TABLE I-2.--Coal trace element analysis

Drill Hole	360		366		385	
Trace Element	Geometric Mean (ppm)	Range (ppm)	Geometric Mean (ppm)	Range (ppm)	Geometric Mean (ppm)	Range (ppm)
Copper	12	5-34	15	5-56	13	6-63
Lead	2.4	0.7-5.0	1.7	0.7-5.0	2.3	0.9-7.0
Selenium	0.5	0.3-2.0	0.3	0.1-2.0	0.5	0.2-2.0
Mercury	0.07	0.02-0.31	0.05	0.02-0.28	0.04	0.01-0.37
Strontium	557	150-970	393	150-980	371	80-900
Cadmium	1.8	0.9-4.0	1.4	0.7-2.0	1.7	0.8-4.0
Molybdenum	3.4	0.8-13.0	2.8	0.7-13.0	7	3-42
Vanadium	19	6-110	20	5-58	18	6-90
Cobalt	1.9	0.8-9.0	1.7	0.7-7.0	3.3	0.2-12.0
Manganese	14	4-28	15	4-37	12	4-36
Arsenic	1.6	0.4-9.0	1.5	0.4-29	1.7	0.4-17.0
Nickel	6	3-30	7	3-20	6	2-15
Boron	16	4-37	14	4-73	8	4-20
Fluorine	25	10-84	30	14-48	27	16-580
Chromium	11	6-23	10	5-20	19	7-80
Zinc	11	2-27	16	6-36	5	2-70
Uranium	2	2-4	2	1-4	4	2-20

Analysis by Commercial Testing and Engineering Co., Denver
(Reported from Spring Creek Coal Company Permit Application)

C. PROPOSALS OF THE SPRING CREEK COAL CO.

As proposed, the Spring Creek mine permitted area would include all or parts of sections 22, 23, 24, 25, 26, 27, and 36, T. 8 S., R. 39 E., and sections 19, 20, 29, 30, 31, and 32, T. 8 S., R. 40 E. (Montana Principal Meridian) plus additional lands to be permitted for an access road and railroad/utility corridor, shown in figure I-8.

Mine development would include three distinct phases: construction of the associated facilities; mining of coal and clinker (scoria) and concurrent reclamation; and abandonment of the mine upon the completion of mining.

1. CONSTRUCTION OF FACILITIES

When the pending permit applications have been approved, Spring Creek Coal Co. would begin construction of coal-handling facilities, railroad spur and loop, access roads, warehouse, administration and maintenance buildings, explosive materials storage, water pumping and waste disposal systems, stream diversions, and electric utilities. Construction activities would also include the quarrying of clinker (scoria) for use as road building materials, stream diversion lining, and railroad subgrade construction material.

Approximately 897 acres would be under permit for construction activities; of this area, a smaller area would be subject to actual disturbance. Before starting construction, the company would remove topsoil from all areas to be affected, and stockpile it for use in the reclamation of those areas.

Surface coal handling and support facilities, except for portions of the access road and railroad/utility corridors, would be in part of section 24, T. 8 S., R. 39 E., and in parts of sections 19, 29, and 30, T. 8 S., R. 40 E., upon surface underlain by burned or sparse, discontinuous coal. Figure I-9 shows locations of the proposed facilities.

a. Access Road

Access to the Spring Creek mine would be provided by the construction of approximately 1.5 miles of roadway (fig. I-9) extending from FAS Route 314, in the NW1/4 sec. 18, T. 8 S., R. 40 E., generally southwestward along a 100-foot right-of-way to the mine office area. At present, the company has a temporary right-of-way issued by the BLM that would have to be reissued as a permanent right-of-way. All costs of road design, construction and acquisition of right-of-way would be borne by Spring Creek Coal Co.

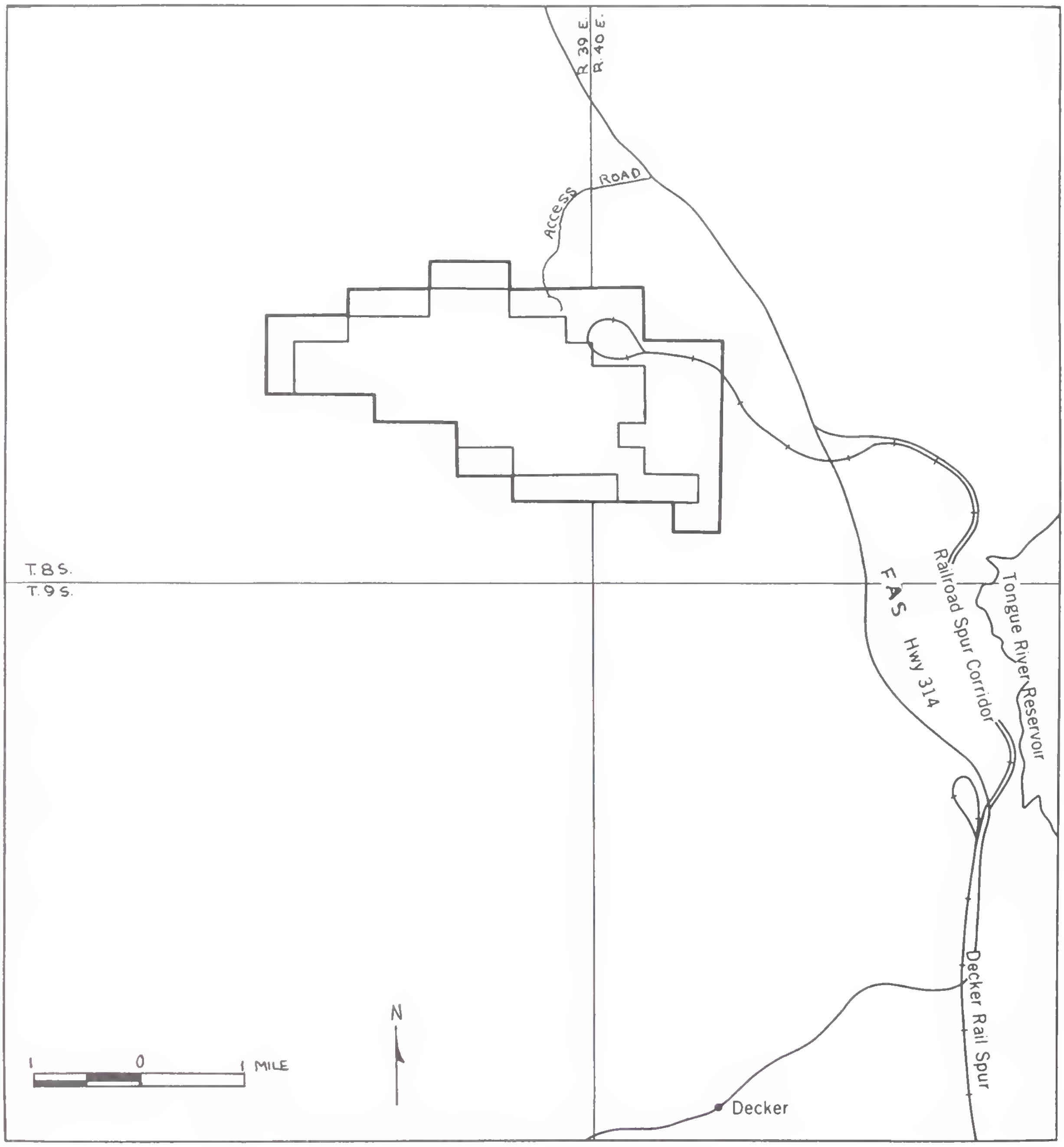


FIGURE I-8.--Map showing proposed railroad corridor and access road.

b. Railroad and Powerline

At the present time, a railroad spur from the Burlington Northern Railroad main line near Sheridan serves the existing West Decker and East Decker mines. Construction of an extension of the spur track northward to the facility location (fig. I-9) would provide rail service for the Spring Creek mine. Before building the railroad the company would have to obtain a right-of-way from the Montana Department of Natural Resources and Conservation, the BLM, and Decker Coal Co..

The railroad spur would end in a broad loop that would facilitate rapid loading of the coal trains. Culverts would be used in crossing all stream channels. The company has proposed, in conjunction with Decker Coal Company, to relocate a portion of FAS 314 eastward to haul roads, coal handling facilities, and the shop area; equipment washing; and fire control. Water consumption for watering haul roads would be highly variable and would be dependent on ambient temperature, the margin of the Tongue River Reservoir. This proposal was generally discussed in the Environmental Impact Statement, Decker Mines, Big Horn County, Montana (USDI, 1977). By relocating FAS 314, the railroad spur would run roughly parallel to the highway on the west side thus avoiding the need for any grade crossings or separations.

A 230-kV powerline would be built along the railroad corridor to the mine facility site where a substation would be built. Incoming power to the mine would be transformed down to 7,200 V to provide power for the major mine equipment (dragline, drills, and shovels); and would be further reduced to 440/220/110 V to supply the coal-handling and miscellaneous facilities. It is assumed that the company would design the powerline to avoid unnecessary impacts to eagles and other raptors.

Electrical powerlines within the coal-handling facility would be buried, and armored cable would distribute power to secondary transformers located throughout the area. From the primary substation, power would be carried by overhead lines to portable substations from which insulated trailing cables laid on the ground would carry power to the in-pit equipment. The electric shovels, dragline, and the coal-handling facility would be the major consumers of power at the mine. The connected load of the three shovels would be about 3,180 kw (demand load), and that of the coal facility about 5,970 kw (demand load). The dragline and overburden drill would use about 3,710 and 371 kw (demand load), respectively.

c. Structues

Mine facilities consisting of offices, maintenance shops, warehouse, change room, and bath facilities would be housed in steel-frame buildings.

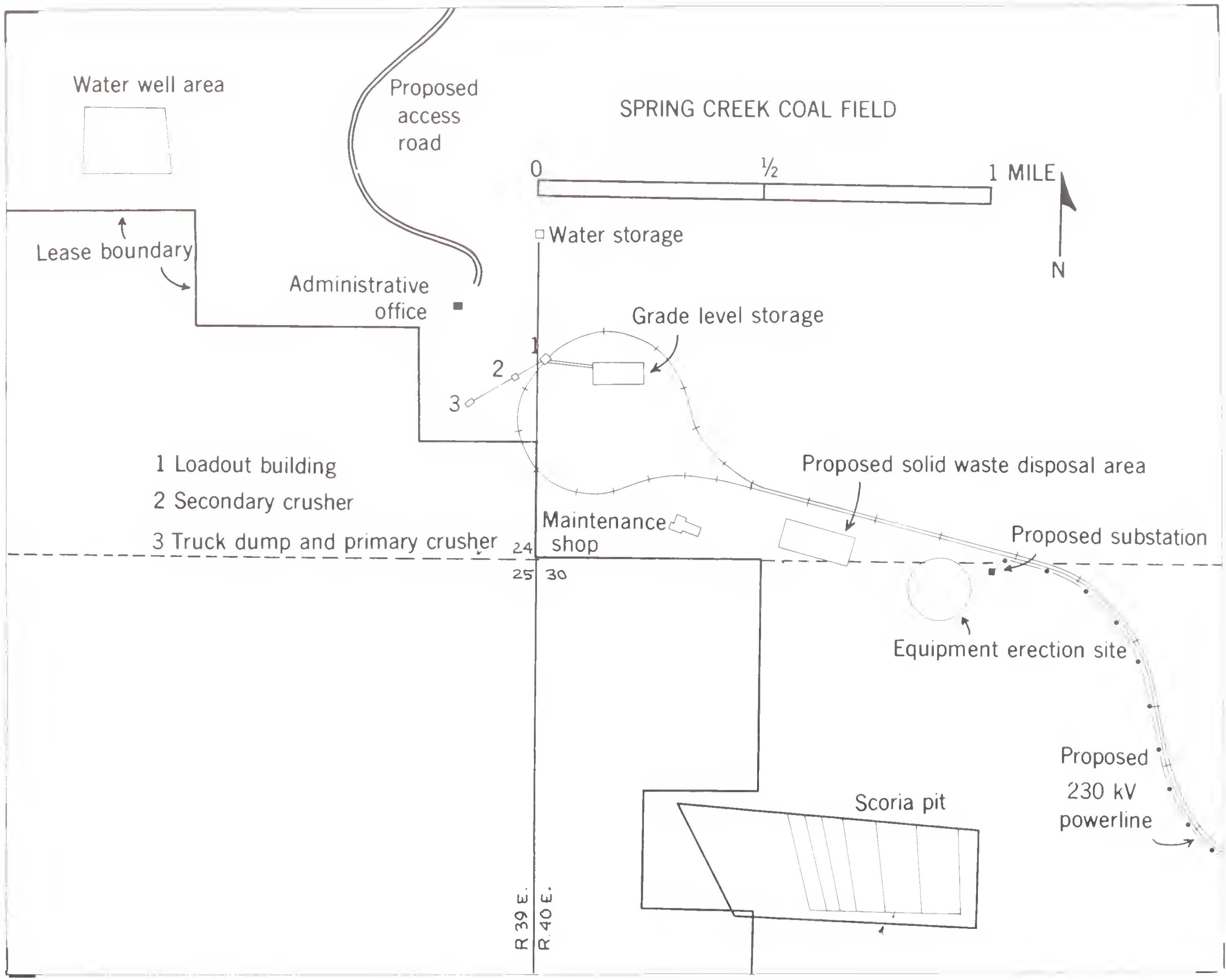


FIGURE I-9.--Map showing mine facilities for the Spring Creek mine.

d. Fuel and Explosive Storage

Diesel fuel, for equipment and use with ammonium nitrate prills (bead like pellets), would be stored in above ground tanks and gasoline would be stored in underground tanks in the vicinity of the maintenance shop. Two fuel islands, one for each type of fuel, would be constructed. Estimated annual fuel consumption would be 32,000 gallons of gasoline and 2.25 million gallons of diesel fuel.

Explosives for use at the mine would be stored as follows: class A (blasting caps, precast primers, and primacord) would be stored in a powder magazine; class B (water gels and sensitized prills) would be stored in approved drop trailers; and class C (bulk prills) would be kept in storage silos, well removed from fuel storage areas. Although separate, these facilities would be adjacent to one another. Storage areas for blasting materials would be located in accordance with applicable federal regulations (30 CFR 715.19).

Ammonium nitrate prills are not classified as explosives until a sensitizing agent such as fuel oil is added. Spring Creek Coal Co. estimates an annual consumption of 6.4 million pounds of prills and 1.1 million pounds of water gels.

e. Coal Processing and Storage Facilities

Coal transported from the pit area by end-dump trucks of 120-to-170 ton capacity would be unloaded at the truck dump where a gravity feed would lead to the primary crushers. Primary crushers would reduce the coal to a maximum diameter of less than 9-inches. An elevated conveyor would transport the coal to a second crusher which would reduce the coal to a size no greater than 2 inches in diameter. A second conveyor would then transport the crushed coal to the loadout facilities. Under normal conditions, coal would be transferred from the loadout by conveyor to the storage facility. The storage facility would consist of an enclosed travelling stacker and drum reclaimer located at grade. Coal would next be transferred from the storage facility by conveyor to the loadout building where it would be sampled, weighed and loaded into rail cars. In an emergency coal could be loaded directly into rail cars by conveyor from the secondary crusher.

f. Water Supplies and Waste Disposal

Major industrial water use would include dust suppression for haul roads, coal-hanbdling facilities, and the shop area; equipment washing; and fire control. Water consumption for watering haul roads would be highly variable and would depend on ambient temperature, wind, the length of the haul road, and the kind of equipment operating. Additional water would be required for employee needs.

Water for haul-road dust suppression would average 67,000 gallons per day (gpd), and would be obtained from ground water inflow to

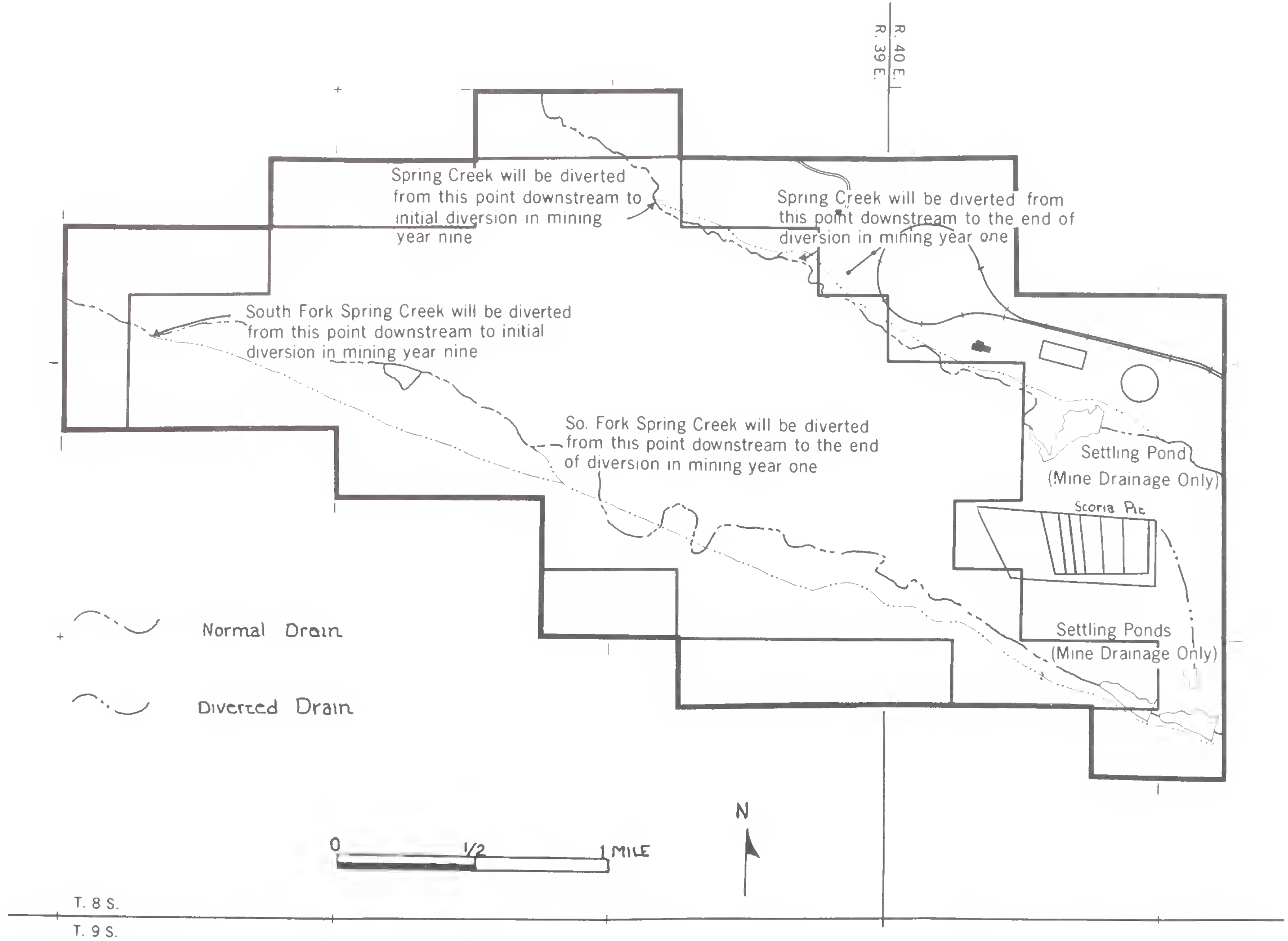


FIGURE I-10.--Map showing drainage plan.

the mine pits. Additional water needs would be supplied by water wells near the plant site (fig. I-8). Water for dust suppression in the coal-handling facilities is estimated to average 124,000 gpd. Water from the wells would be stored in two water tanks having a combined capacity of 800,000 gallons. These tanks would be located northeast of the office complex (fig. I-8). Water for haul road dust suppression not obtained from groundwater inflow into the pit area would be provided by a standpipe near the maintenance shop.

A solid refuse disposal area would be used for noncombustible solid wastes.

g. Haul Roads

All haul roads would be about 100 feet in width and would be surfaced with crushed clinker (scoria) from the mine and scoria quarry area. Roads constructed for the purpose of hauling coal and overburden, and the general purpose roads in and around the mine, would be designed and built by mine personnel with mine equipment. All roads would be constructed to drain adequately according to Federal and State agency guidelines. Haul roads would not be blacktopped but would be sprinkled regularly with water for dust suppression.

Haul roads would be maintained on grades of at least 7 percent out of the pit in order to minimize their lengths through the spoil areas, and thus allow for a minimum amount of disturbed land at any one time. No more than two ramp roads per mile would emerge from the pits to the surface.

h. Water Diversion and Impoundment

Two ephemeral streams, Spring Creek and South Fork Spring Creek, would be disrupted by the mine. South Fork Spring Creek, which flows from northwest to southeast across the southern part of the permit area, has the greatest length exposed to mining level disturbance, but has a smaller drainage area than Spring Creek. Spring Creek, to the north of South Fork and flowing in a parallel direction, crosses the permit area's northeast edge.

Both Spring Creek and South Fork would require diversion if the mine plan is permitted. Two diversions of South Fork would take place during years 1 and 9 of the mining operation and would involve 14,800 and 7,800 feet of the stream channel, respectively. Spring Creek would also be diverted in two steps. Preceding mining, 8,200 feet of Spring Creek would be diverted to the north of the mining area; in year 9, an additional 2,600 feet would be diverted. Figure I-10 shows both the location and the timing of the proposed stream diversions.

According to the company's calculations based on the Precipitation-Frequency Atlas of the Western United States (NOAA Atlas 2), engineered channels for the diversions would be capable of passing the

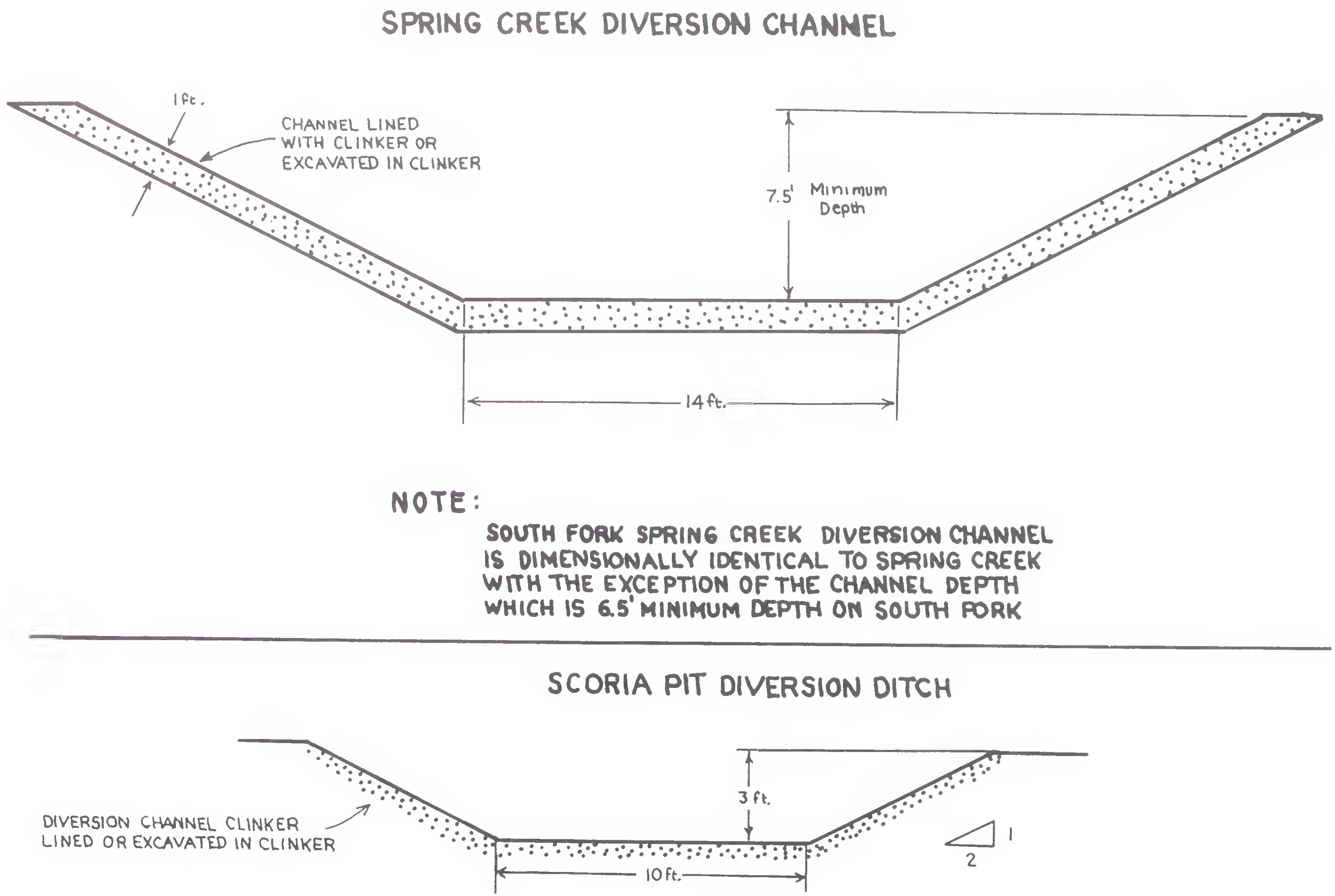


FIGURE I-11.--Diagrams showing diversion channel construction.

50-year peak flow with freeboard. This flow would be expected from a storm with a duration of 6 hours and a precipitation of 2.2 inches. The channels would have a bottom width of 14 feet with side slopes of 2:1. Where the channels would be excavated in easily erodible material, the sides and bottom would be lined with a one-foot thick layer of clinker (fig. I-11).

Approximately 10,000 feet of the relocated channel of Spring Creek would have a minimum depth of 7.5 feet and would pass a 50-year peak flow with about 3/4 foot of freeboard. The final 800 feet of relocated channel would be excavated in clinker to form cascades and rapids to dissipate the energy of the water prior to reentering the existing Spring Creek channel.

About 22,100 feet of the relocated channel of South Fork would be constructed to a minimum depth of 6.5 feet. This channel would pass the 50-year peak flow with a minimum of about 1/2 foot of freeboard. To maintain the slope of the channel at 0.0075 (about 1/4 degree), a series of drop structures would be constructed. The drop structures would consist of 3-foot high gabions of steel wiremesh baskets filled with clinker. The final 500 feet of the relocated channel would be excavated in clinker to form cascades and rapids to dissipate the energy of the water prior to reentering the existing South Fork Spring Creek channel.

The mine plan would ensure that the diversion channels approximate the existing channel characteristics of Spring Creek and South Fork. Although their gradients would be somewhat greater, the new channels would be lined with clinker, to increase the coefficient of friction, and would have drop structures built into them. Those features would reduce the erosion potential of the steeper channels.

At no time would runoff from either of the stream channels be allowed to drain into the mine area. To protect the mine from excess water during periods of heavy precipitation and runoff, the company proposes to establish perimeter ditches around the high sides of the active mine pits, in addition to diverting the two creeks away from the mining operations.

Runoff from the mine area as well as that from the scoria pit area would be collected in settling impoundments (fig. I-10). Also, water not needed for dust suppression would be collected in the active pits and pumped into the impoundments. All impoundment dams would be earthfill structures consisting of compacted impervious cores and compacted random fill upstream and downstream shells (fig. I-12).

The runoff from the Spring Creek drainage would be collected in a 90-acre-foot impoundment, while runoff from South Fork would be collected in two impoundments of 34 and 64-acre-feet, respectively. Runoff from the "scoria pit" would be diverted towards South Fork in a diversion ditch having a slope of 0.01 (about 1/2 degree) (fig. I-11).

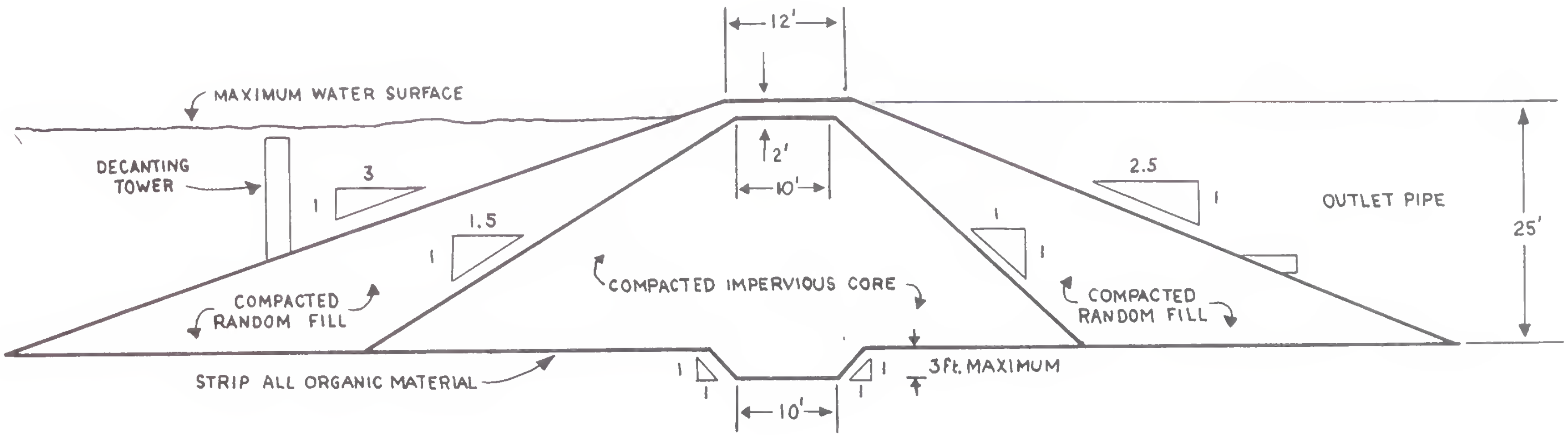


FIGURE I-12.--Sketch showing typical dam section.

This runoff would be collected in an impoundment having a capacity of 14-acre-feet.

All diversion-ditch banks and impoundment dam banks would be sown with a vegetative cover to reduce erosion of both the banks and the structures.

2. MINING AND RECLAMATION

Overburden removal would start approximately 6 months before the completion of construction. State and Federal laws dictate that mining plans can be approved at any one time for a period of only 5 years. At the end of 5 years, Spring Creek Coal Co. would have to obtain another 5-year permit to continue mining in accordance with its proposal. For this reason, the life of the mine will be addressed, and those proposals which would be covered by the 5-year permits emphasized.

The company proposes to mine approximately 40 million tons of coal in the first 5 years of production, beginning in 1980. The first year's production would be about 3 million tons; the second year, 7 million; and, every year thereafter, 10 million tons.

The company proposes to open the mine using conventional stripping and mining equipment. During the first 2 years of the operation, two initial box cuts would be opened (fig. I-13). The first box cut would start in the northeastern corner of the property (NW1/4 sec. 30, T. 8 S., R. 39 E.) and proceed northwesterly. Upon completion of overburden removal from the first cut, the dragline would be "walked" to the western end of the second box cut (SE1/4 sec. 22, T. 8 S., R. 39 E.). Overburden removal in the second cut would progress in a southeasterly direction. Successive cuts would parallel the first two cuts and progress in a counterclockwise direction. Upon completion of the first two box cuts, essentially three pits would be formed. These would result from the first box cut and the eastern and western portions of the second box cut.

Spoil material from the first box cut would be cast to the north of the pit on unmined land clear of all vegetation and topsoil material (fig. I-14). This spoil material would later be replaced in the initial box cut. The spoil material from the second box cut would be cast to the north, along the western half of the pit, and to the south along the eastern half. Orientation of the pits according to the mining sequence would allow for the equalization of the stripping ratio. In each successive pass, the overburden would be placed in the previously mined-out cut. This cycle would be repeated for the 25-year life of the mine. At the final cut, a highwall would form the upslope side of the pit. As proposed by the company, the final highwall would be reduced by grading the upslope material into the final pit at a slope of 36 percent (20 degrees), within the requirements of 30 CFR 715.14(a)(2). Figure I-15 shows a typical method of highwall reduction.

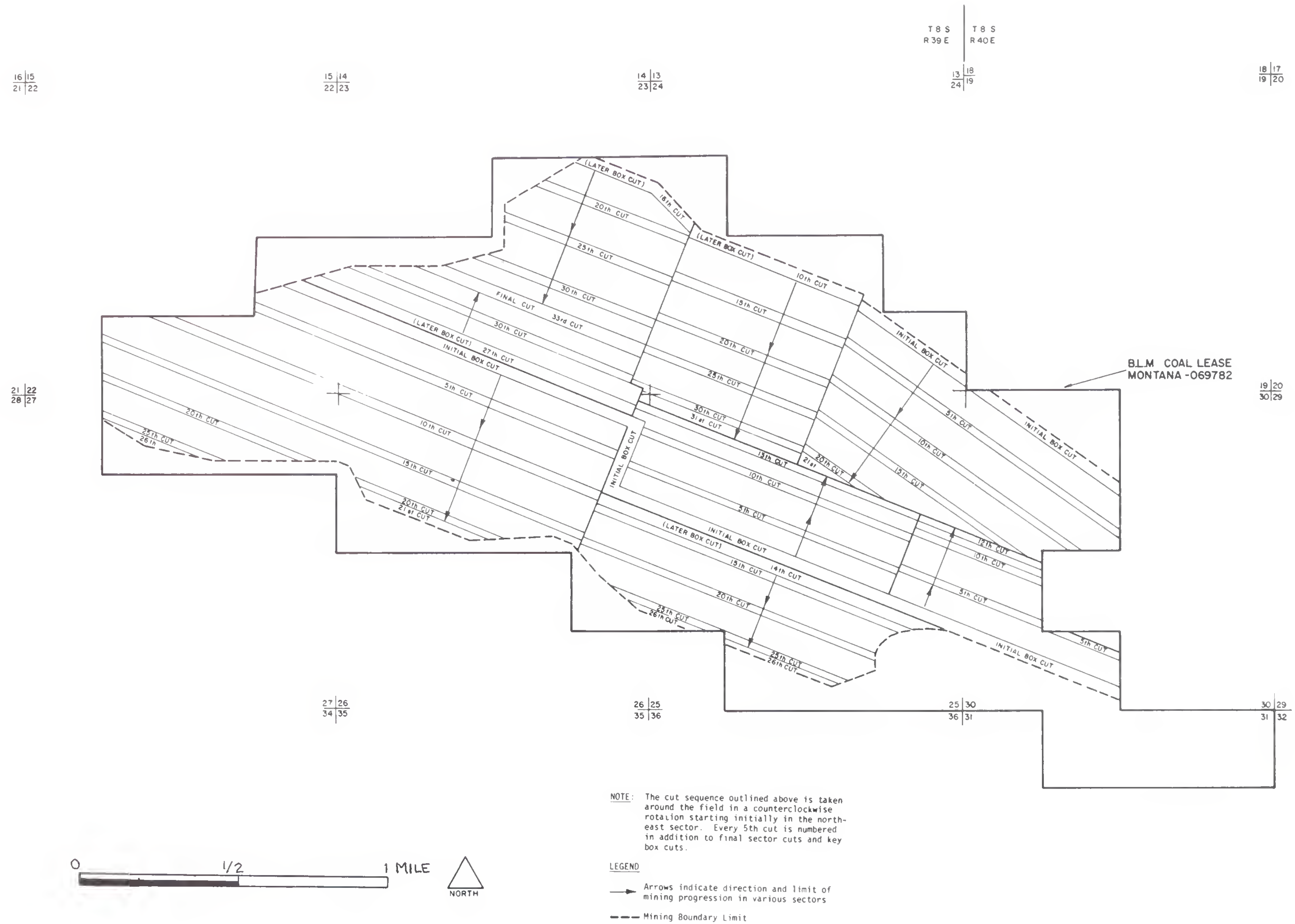


FIGURE I-13.--Map showing the proposed progression of mining.

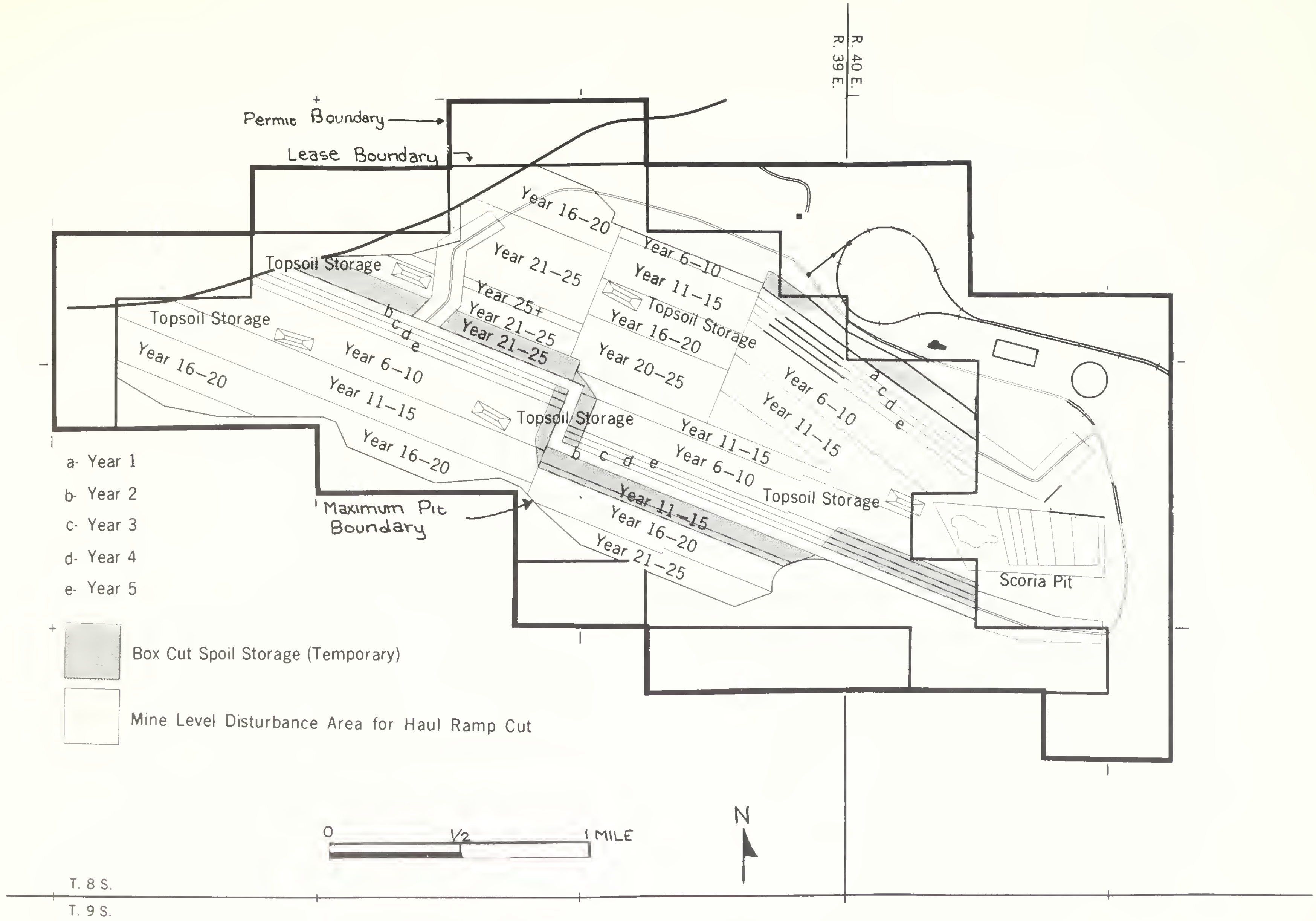
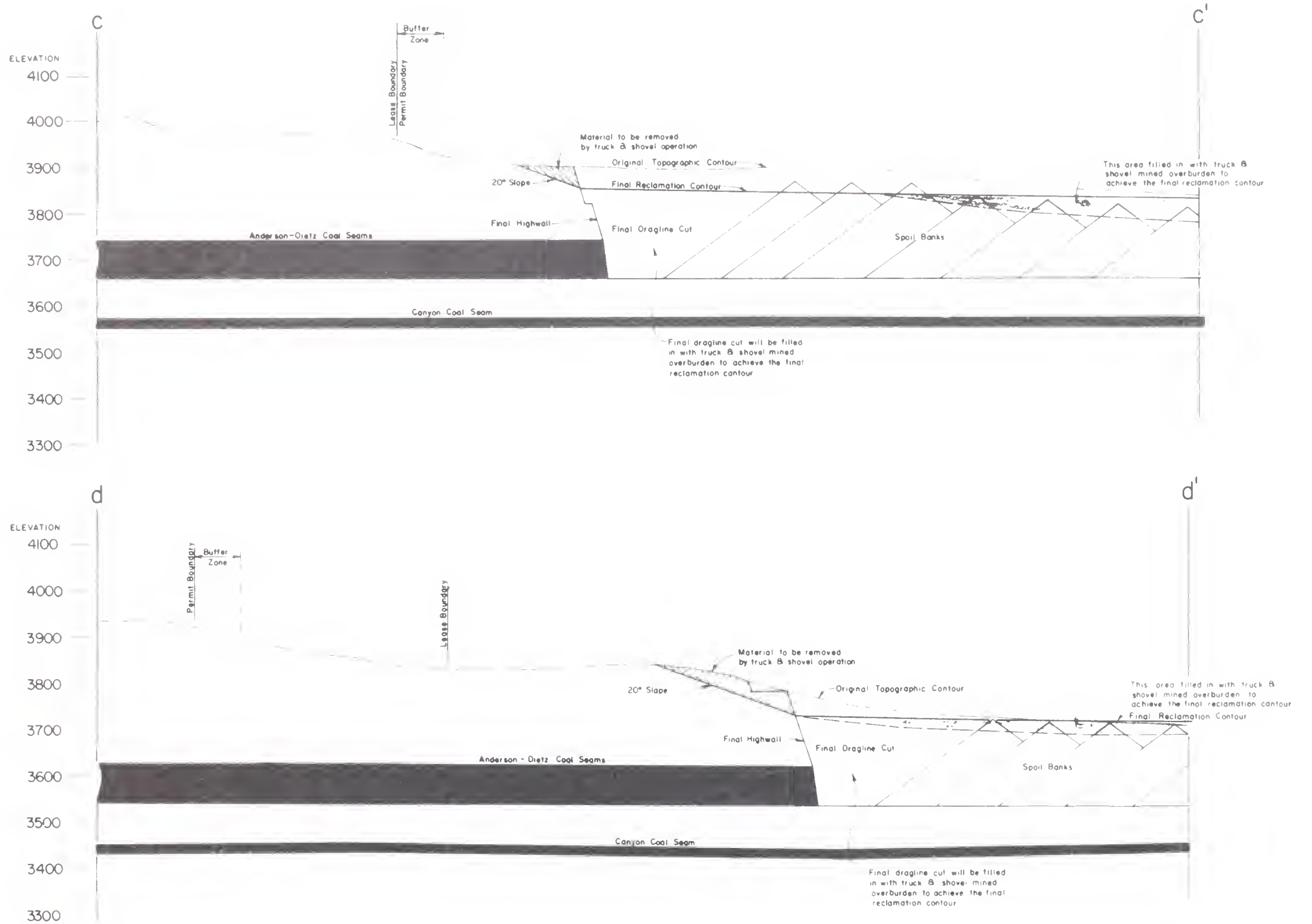


FIGURE I-14.--Map showing overburden and topsoil storage.



NOTE
Both sections look northwest at the southern bluff highwall reduction
Check Figure I-
for location

FIGURE I-15.--Cross section of highwall reduction.

Concurrent with the mining of coal would be the quarrying of clinker. This material would be obtained from the bluffs to the east of the mine area and from the clinker caps of the bluffs within the coal lease boundary (fig. I-14). Present plans call for private contractors to quarry and crush the clinker for use as a topping material on haul roads and auxillary roads. The quarrying would take place during the 3 summer months of each year, the crushed clinker would be stockpiled for later use.

The mining application proposes to permit a total of 4,420 acres. During the first 5 years approximately 312 acres would be disturbed by coal mining; 757 acres by other mining level disturbance, including 20 to 30 acres for clinker excavation; 897 acres for facilities disturbance (a smaller area will be subject to actual disturbance); 2,293 acres for associated disturbance; and 161 acres for a buffer zone around the disturbed area (fig. I-16). It is anticipated that mining would disturb approximately 70-100 acres per year. At the end of the 25-year life of the mine, coal would be removed from about 1850 acres and clinker from about 95 acres.

a. Soil Material Removal and Storage

Beginning with the earliest construction activities and continuing through the life of the mine, topsoil would be removed from all areas affected by construction, removal of overburden, or placement of spoils. All available topsoil would be removed in advance of mining by self-loading and/or conventional rubber-tired scrapers. The topsoil and other material of seedbed quality would then be hauled either to predetermined stockpile locations (fig. I-14) or redistributed directly on the graded spoils. In addition to topsoil, material would be salvaged from depths below the "A" horizon if it were at least the seedbed quality of material presently on the surface.

Topsoil stripping and replacement would be an integral part of mining and reclamation. After sufficient areas have been mined, backfilled, and recontoured, topsoil removed in advance of mining would be transported and placed on the recontoured spoils in a single operation, avoiding insofar as possible the need to stockpile.

When topsoil is not to be replaced on a backfill area within a period of time when such soil might deteriorate, the company proposes to establish and maintain an approved cover of quick-growing vegetation or employ other approved protection measures in accordance with State and Federal regulations. Such measures would protect the soil from erosion, discourage the establishment of noxious plant species, and maintain the soil in a condition suitable for sustaining vegetation when used in reclamation.

b. Overburden Removal

After the topsoil has been removed, areas requiring overburden stripping would be drilled and blasted using ammonium nitrate fuel-oil

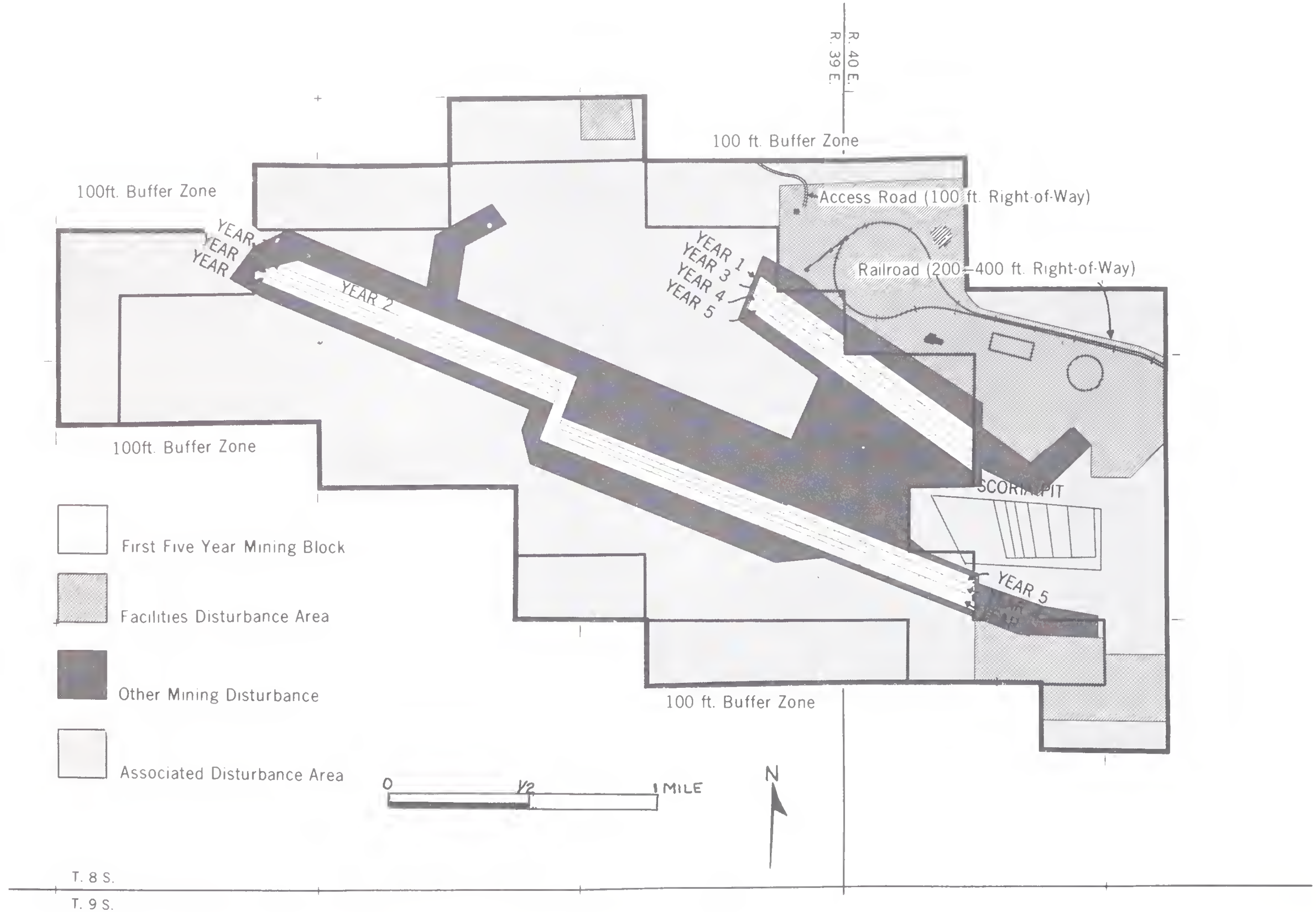


FIGURE I-16.--State bonding map for mining disturbance.

mixture (ANFO). The amount of explosive placed in each hole would depend on the characteristics and configuration of strata to be blasted and the spacing of the adjacent holes.

High-explosive primers would be detonated by primer cord and would themselves initiate prill detonation in each blast hole. Blasting would be scheduled for day shifts only, five days a week. Blasting procedures would be in keeping with all safety regulations. The company currently estimates that 5-to-6 blasts per week would be detonated.

Because of the variable thickness of overburden, the method of overburden removal would also vary (fig. I-17). A two-step system of stripping, using a large mining shovel and truck fleet, is planned where overburden thickness exceeds 120 feet.

Trucks of 120-to-170 ton capacity would move overburden to areas requiring fill material to achieve reclamation goals. A walking dragline (52 $yd.^3$) would then remove the overburden below the 120-foot cover line and deposit it in a previously mined pit. Where the overburden was less than 120 feet thick, the first shovel and truck removal step would not be necessary.

The company anticipates that blasting, loading, and dumping would cause overburden to expand in volume by about 25 percent. However, some compaction (possibly as much as 5 percent) would result from the movement of heavy equipment during regrading and the replacement of topsoil.

c. Coal Drilling, Blasting, and Removal

Drilling and blasting would be used to break up the coal seam. Blasting procedures would be similar to those used to break up the overburden. Large power shovels (one in each active pit), equipped with coal dippers of approximately 25-30 cubic yard capacity, would load the coal into trucks (120-to-170 ton capacity) for transport to the coal handling facilities.

d. Reclamation

In accordance with State and Federal laws, Spring Creek Coal Company proposes to reclaim all mined and associated-disturbance areas to meet the required standards should the mining and reclamation plan be approved by the appropriate regulatory agencies.

(1) Spoil Reclamation

Reclamation of disturbed land resulting from stripping and mining would lag, by one or two rows of spoil behind each operating dragline pit to facilitate proper "cut and fill" techniques on the piles. Figure I-18 shows those areas to which supplemental material would be transported. The spoil material would be leveled to the re-

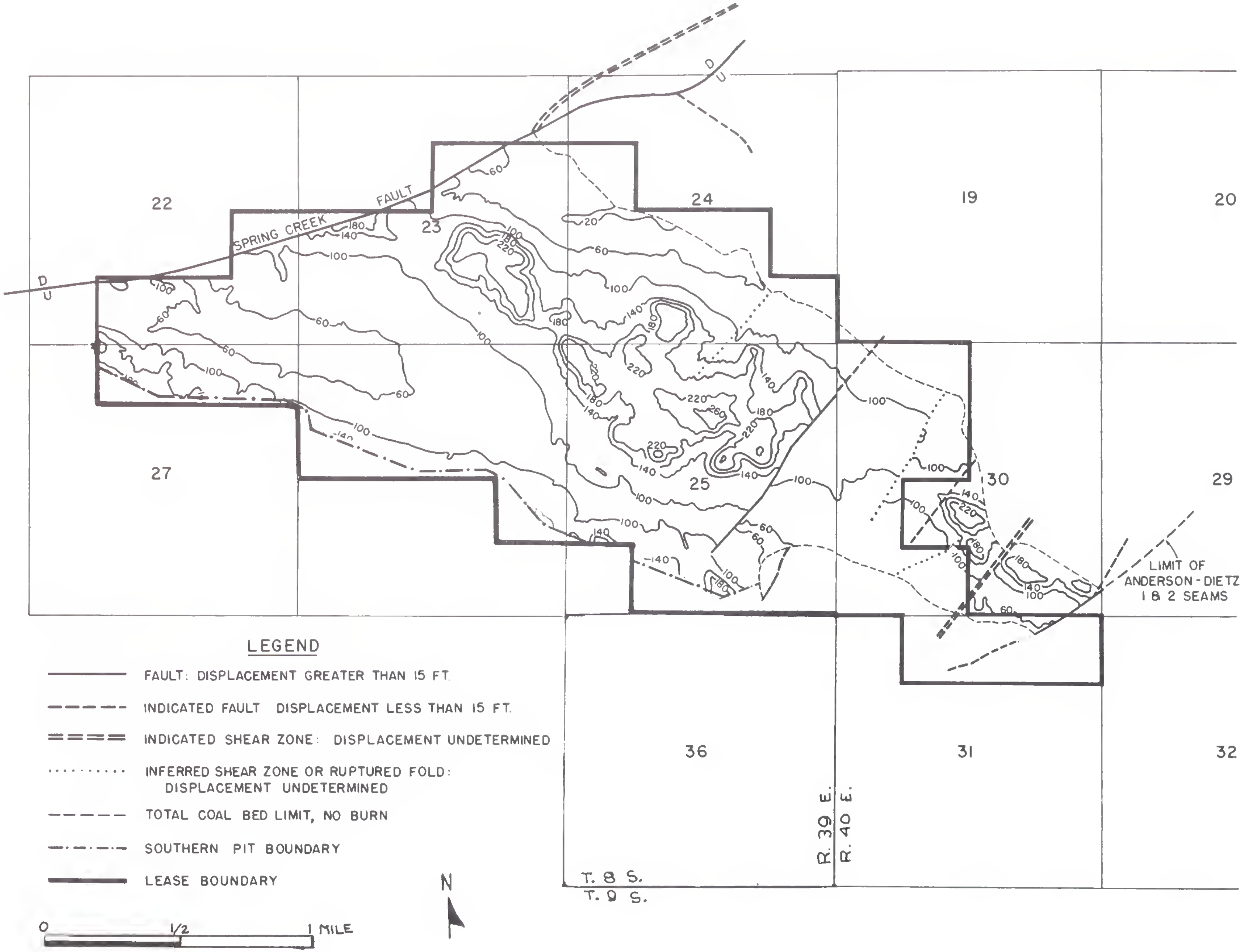


FIGURE I-17.--Overburden isopach for stripping.

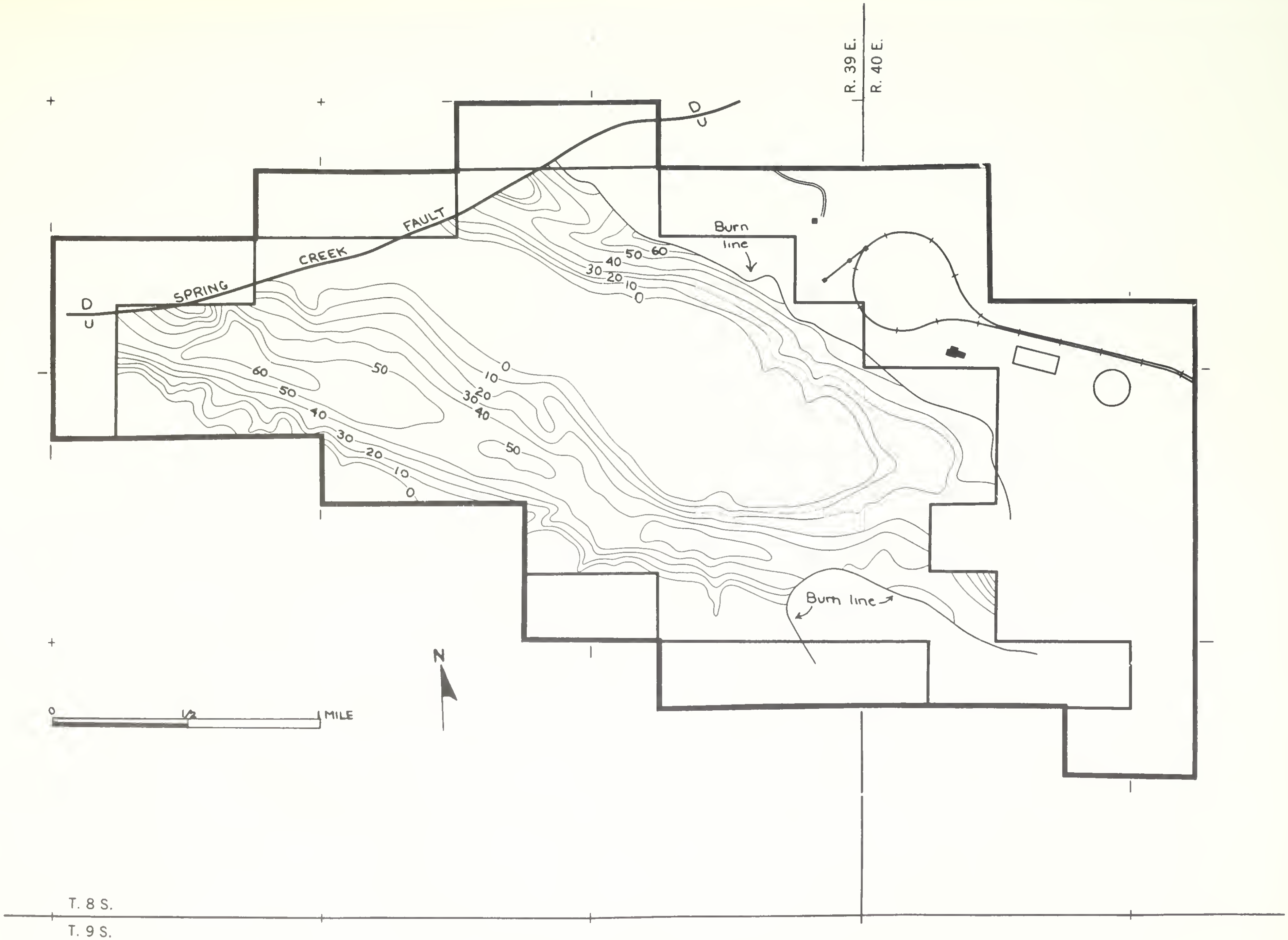


FIGURE I-18.--Fill area isopach for truck and shovel stripping.

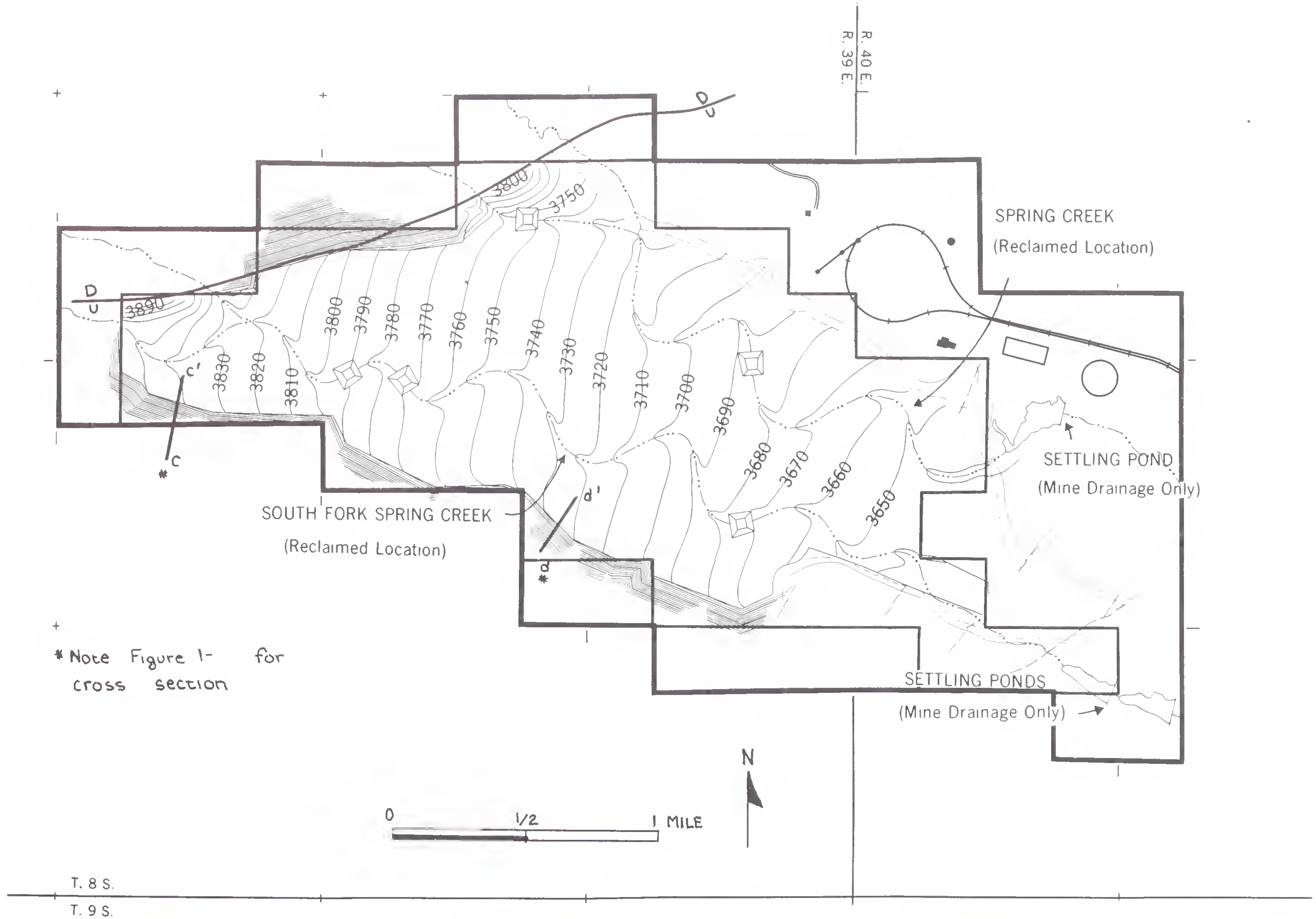


FIGURE I-19.--Postmining topography.

quired contours. Except for the highwalls which would have 20-degree slopes (36 percent), the maximum slopes permitted after reclamation would be about 11 degrees (20 percent). The proposed final topography for the reclaimed area is shown in Figure I-19.

As encountered, thin unminable coal seams and other materials unsuitable for revegetation would be buried to a minimum depth of 8 feet below the reclaimed surface. Immediately prior to topsoil replacement, the spoil surface would be ripped or disced to provide a more natural interface between the regraded spoils and redistributed topsoil and to enhance stabilization of reclaimed areas.

(2) <u>Topsoil Redistribution</u>

Topsoil to be placed on regraded spoil surfaces would be obtained from either topsoil stockpiles or directly from areas where topsoil is being removed in preparation for mining. As indicated on page 38, topsoil would be replaced directly on spoil surfaces without stockpiling, insofar as possible. The company anticipates that approximately 2 feet of topsoil would be spread over reclaimed surfaces except along the flood plains of the stream channels, where 4 feet of topsoil would be placed.

Topsoil amendments in the form of annual cover crops, mulching, and fertilizer have been proposed by the company, which are expected to meet statutory requirements. An annual cover crop such as millet would be sown on areas receiving a direct placement of topsoil to provide a protective cover during the establishment of a permanent, diverse vegetation cover. On areas where the topsoil is from a topsoil stockpile, a straw or hay mulch would be applied at a rate of two tons per acre and crimped or disced into the topsoil prior to seeding. The application of fertilizer would be based on the results of soil tests conducted after topsoiling operations were completed. Required fertilizer amendments would normally be applied during the second growing season following vegetation establishment.

e. Postmining Stream Reclamation

After the completion of mining and reclamation, Spring Creek and South Fork Spring Creek would occupy channels within reconstructed floodplains located on the reclaimed mine area. The entire floodplain would be stabliized by vegetation and the low-flow channel would have a gradient similar to that of the presently active stream channel.

The Spring Creek floodplain would be 10,500 feet long and would start at elevation 3,720 and end at elevation 3,620 (a gradient of one-half degree). This floodplain would be 20 feet wide with a 200-foot wide bottom and 25-foot wide sides having slopes of 10-to-1. The low-flow channel would be 18,200 feet long and would be trapezoidal in shape with an 8-foot wide bottom. The total depth would be 2 feet and side slopes would be 2-to-1, resulting in a 16-foot wide top.

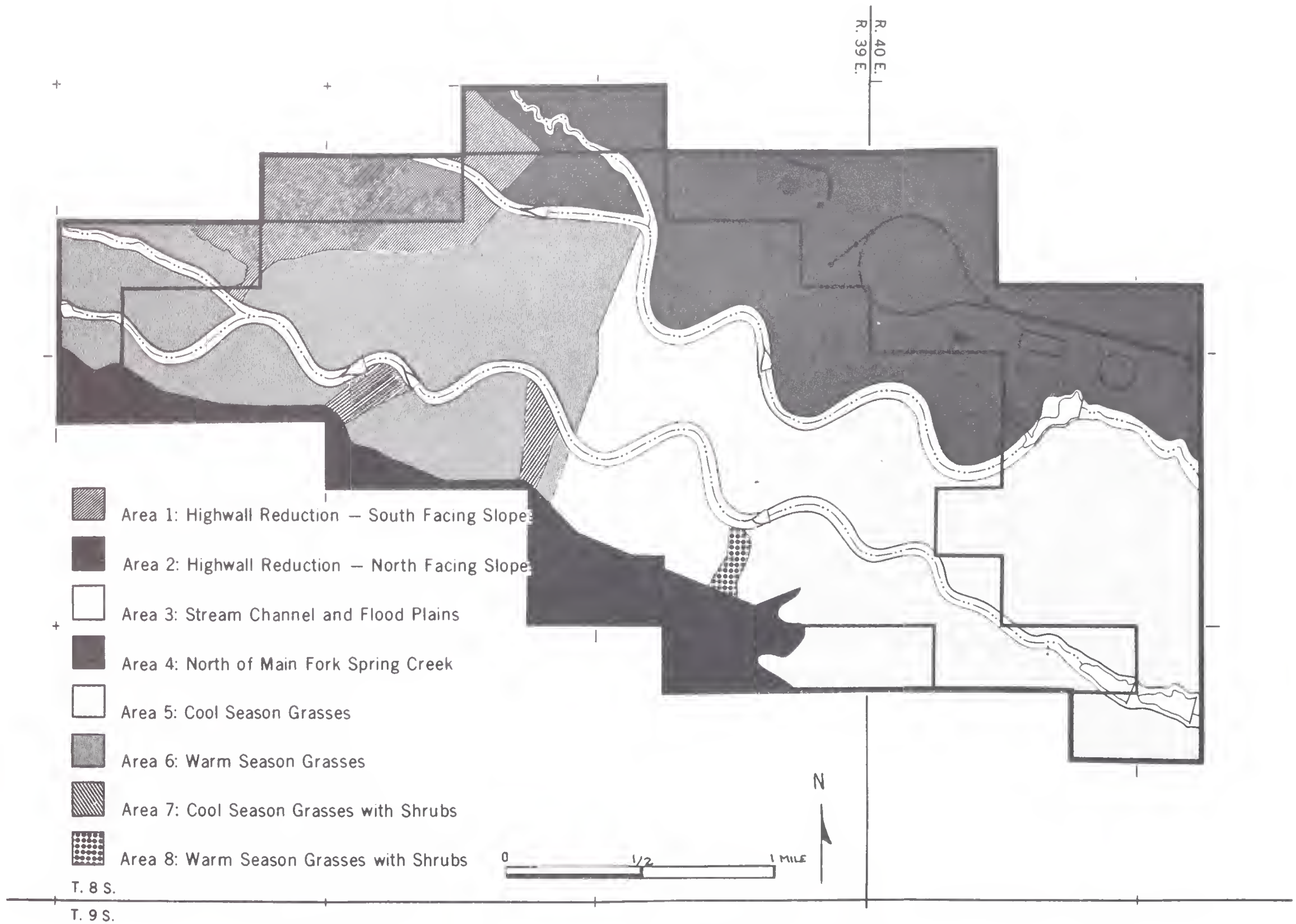


FIGURE I-20.--Reclamation-revegetation plan map.

The South Fork Spring Creek floodplain would be 22,500 feet long and would start at elevation 3,850 and end at elevation 3,600 (a gradient of two-thirds degree). The floodplain would be 200 feet wide with a 150-foot wide bottom and 25-foot wide sides having slopes of 12.5-to 1. The low-flow channel would be trapezoidal in shape and would be 39,000 feet long with an 8-foot wide bottom. The total depth would be 2 feet and side slopes would be 2-to-1, resulting in a 16-foot wide top.

f. Ponds

Stock watering ponds would be constructed on both Spring Creek and South Fork. These ponds would be excavated so that the bottom of the ponds would be 10 feet below the floodplain level. The ponds would be 200 feet square at the bottom and would have side slopes of 10-to-1. There would be 2 ponds on Spring Creek and 3 ponds on South Fork (fig. I-19).

g. Seeding

Upon the completion of seedbed preparation, areas to be reclaimed would be seeded or planted during the first appropriate season, not to exceed 90 days from the date of seedbed preparation. The goals of reclamation would be to establish a permanent, diverse vegetation cover of predominantly native species on all affected lands except traveled portions of railroad loops and roadways or areas of authorized water confinement.

In accordance with State and Federal laws, the company proposes to drill-seed reclaimed areas with locally grown, genotypical seed, when available. Seeding would be done on the contour. Six site-specific seeding mixtures have been developed for the Spring Creek permit area based upon preplanning vegetation inventories, the proposed reclamation use, and pertinent laws. These six seeding mixtures are included in table I-3. Figure I-20 shows the proposed areas where each mixture would be planted. Reclamation work would be monitored continuously by qualified reclamation specialists employed by the company.

3. ABANDONMENT OF MINE

After mining operations cease, buildings and access facilities would be removed and sites occupied by them would be reclaimed by replacing topsoil and of revegetation. The company anticipates that about 2 years would be required for reclamation of those areas.

4. EMPLOYMENT REQUIREMENTS

During the first few years of construction and production, the number of employees would vary. The company anticipates a peak employment force of about 480 employees who would be hired on a nonpermanent basis, with peak employment occurring in April or May 1980. Construction is scheduled to be completed in late 1980 should the permit be approved within the time frames anticipated by the company.

TABLE I-3.--Seeding mixtures

[Rates indicated are pounds pure live seed per acre]

Rate	Common name	Scientific name
AREA #1 - Highwall Reduction--South-Facing Slopes:		
0.5#	Rubber rabbitbrush	- *Chrysothamnus nauseosu*
0.5#	Schadscale saltbush	- *Atriplex confertifolia*
1#	Winterfat	- *Eurotia lanata*
1#	4-Wing saltbush	- *Atriplex canescens*
2#	Western wheatgrass	- *Agropyron smithii*
3#	Green needlegrass	- *Stipa viridula*
2#	Beardless wheatgrass	- *Agropyron inerme*
2#	Indian ricegrass	- *Oryzopsis hymenoides*
3#	Critana thickspike	- *Agropyron dasystachyum*
2#	Bottlebrush squirreltail	- *Sitanion hystrix*
2#	Slender wheatgrass	- *Agropyron trachycaulum*
AREA #2 - Highwall Reduction--North-Facing Slopes:		
1#	Skunkbush sumac	- *Rhus trilobata*
1#	Antelope bitterbrush	- *Purshia tridentata*
1#	Winterfat	- *Eurotia lanata*
1#	4-Wing saltbush	- *Atriplex canescens*
3#	Western wheatgrass	- *Agropyron smithii*
3#	Green needlegrass	- *Stipa viridula*
2#	Sideoats grama	- *Bouteloua curtipendula*
2#	Prairie sandreed	- *Calamovilfa longifolia*
2#	Little bluestem	- *Andropogon scoparius*
2#	Beardless wheatgrass	- *Agropyron inerme*
2#	Thickspike wheatgrass	- *Agropyron dasystachyum*

In addition to this seeding mixture, selected plantings of ponderosa pine (Pinus ponderosa) and juniper (Juniperus scopulorum) will also be made.

Rate	Common name	Scientific name
AREA #3 - Stream Channel and Flood Plains:		
2#	Prairie sandreed	- *Calamovilfa longifolia*
3#	Smooth brome	- *Bromus inermis*
3#	Western wheatgrass	- *Agropyron smithii*
3#	Streambank wheatgrass	- *Agropyron riparium*
3#	Pubescent wheatgrass	- *Agropyron trichophorum*
2#	Silver sage*	- *Artemisia cana*

*The seed to be utilized will be hand collected on the site and will be seeded into a 200 ft. buffer zone along the stream channel.

TABLE I-3.--Seeding mixtures--Continued

AREA #4 - North of Main Fork - Spring Creek:

1#	Shadscale saltbush	- *Atriplex confertifolia*
1#	4-Wing saltbush	- *Atriplex canescens*
3#	Western wheatgrass	- *Agropyron smithii*
3#	Green needlegrass	- *Stipa viridula*
3#	Beardless wheatgrass	- *Agropyron inerme*
2#	Bottlebrush squirreltail	- *Sitanion hystrix*
3#	Thickspike wheatgrass	- *Agropyron dasystachyum*
2#	Slender wheatgrass	- *Agropyron trachycaulum*

AREA #5 - East of Section Lines 25 and 26. Predominantly Cool Season Grasses

2#	Western wheatgrass	- *Agropyron smithii*
2#	Green needlegrass	- *Stipa viridula*
2#	Pubescent wheatgrass	- *Agropyron trichophorum*
2#	Blue grama	- *Bouteloua gracilis*
2#	Sideoats grama	- *Bouteloua curtipendula*
2#	Indian ricegrass	- *Oryzopsis hymenoides*
2#	Beardless wheatgrass	- *Agropyron inerme*
2#	Bottlebrush squirreltail	- *Sitanion hystrix*
2#	Little bluestem	- *Andropogon scoparius*
1#	Skunkbush sumac*	- *Rhus trilobata*
1#	4-Wing saltbush*	- *Atriplex canescens*

*Selected corridor areas for wildlife access to water.

AREA #6 - West of Section Lines 25 and 26. Predominantly Warm Season Grasses

3#	Little bluestem	- *Andropogon scoparius*
3#	Sideoats grama	- *Bouteloua curtipendula*
2#	Switchgrass	- *Panicum virgatum*
2#	Thickspike wheatgrass	- *Agropyron dasystachyum*
2#	Beardless wheatgrass	- *Agropyron inerme*
2#	Blue grama	- *Bouteloua gracilis*
2#	Western wheatgrass	- *Agropyron smithii*
2#	Prairie sandreed	- *Calamovilfa longifolia*
1#	Skunkbush sumac*	- *Rhus trilobata*
1#	4-Wing saltbush*	- *Atriplex canescens*

*Selected corridor areas for wildlife access to water.

The company has proposed the building of a temporary construction camp for employees during the initial stages of mine development. The facilities would be in the SW1/4NE1/4 sec. 32, T. 9 S., R. 40 E., Big Horn County, Montana. The camp would consist of a motel-type bachelor's quarters, recreational vehicle hookups mobile home spaces, and

a dining and recreation hall. Food service, maid service, and security would be provided. The camp would accommodate about 220 or more people.

A permanent work force would be hired in accordance with the figures shown in table I-4. Permanent employment would stabilize at about 250 employees in mining-year four.

D. ADDITIONAL REQUIREMENTS TO MEET STATE AND FEDERAL REGULATIONS

1. MITIGATING MEASURES (STIPULATIONS)

a. If the company desires variances from the requirements which relate to the sampling of overburden, the company must obtain a letter from the U.S. Geological Survey authorizing such variances.

b. The application for a strip mining permit must demonstrate compliance with the Strip Mining Control and Reclamation Act of 1977, the regulations pursuant to that act, and the Montana Emergency Reclamation Act of 1973.

c. The company must present a discussion of the feasibility of mining the Canyon coal bed in order for the mining plan to be evaluated under the State and Federal Coal Conservation Acts.

d. The company will probably have to obtain a preconstruction permit from EPA demonstrating: (1) compliance with the prevention of significant deterioration increments in effect at the leasehold, (2) compliance with the Northern Cheyenne Indian Reservation Class I PSD increments.

e. In compliance with Executive Order 11593 and State Policy, the company will meet the requirements of the Montana State Historic Preservation Officer for granting of a cultural resources clearance.

2. MITIGATING MEASURES (CONSTRUCTION)

a. The Montana Department of State Lands may require that access roads be graded. constructed, and maintained in accordance with the following requirements:

(1) no sustained grade shall exceed 8 percent

(2) the maximum pitch grade shall not exceed 12 percent for 300 feet

(3) the maximum pitch grade shall not exceed 300 feet for each 1,000 feet

(4) the grade on switchback curves shall be reduced to less than the approach grade and shall not be greater than 10 percent

(5) cut slopes shall not be more than 2-to-1 in soils of 0.5-to-1 in rock

(6) all grades referred to shall be subject to a tolerance of 2 percent of measurement. Linear measurements shall be subject to a tolerance of 10 percent of measurement

(7) additional requirements may be imposed by the department if special drainage or steep terrain problems are likely to be encountered

b. All cut and fill slopes resulting from construction of access roads, railroad loop, or haul roads outside the area to be mined shall be stabilized and revegetated during the first seasonal opportunity.

c. Drainage ditches shall be constructed on both sides of the through-cut, and the inside shoulder of a cut-fill section, with ditch-relief cross drains being spaced according to grade. Water shall be intercepted before reaching a switchback or large fill, and shall be drained off or released below the fill. Drainage structures shall be constructed in order to cross a stream channel, and shall not affect the flow or sediment load of the stream.

d. Clinker should be placed at the discharge points of the outlet pipes of the settling ponds.

3. MITIGATING MEASURES (MINING)

a. Terracing may be required to conserve moisture and to control water erosion on all graded slopes during the grading process.

b. All mining activities, including highwall reduction, and related reclamation, shall cease 100 feet from a property line; from a permanent structure; from unminable, steep, or precipitous terrain; or from any area determined by the Montana Department of State Lands, with concurrence of the Secretary of the Interior, to be of unique scenic, historical, cultural, or other unique value pursuant to Section 522 of the Surface Mining Control and Reclamation Act and Section 9 (50-1042 RCM, 1947) of the Montana Strip and Underground Mine Reclamation Act.

c. Haul roads through permitted areas shall be allowed providing that their presence does not delay or prevent recontouring or revegetation on immediately adjacent spoils.

d. The company must receive approval from the regulatory agencies prior to the utilization of chemical dust suppressants.

e. Paleontological resources are protected under the Montana State Antiquities Act (81-25 R.C.M. 1947).

4. MITIGATING MEASURES (RECLAMATION)

a. Materials which are not conducive to revegetation techniques, establishment, and growth shall not be left on the top or within 8 feet of the top of regraded spoils or at the surface of any other affected areas. The Montana Department of State Lands may require that problem materials be placed at a greater depth.

b. Box-cut spoils or portions thereof shall be hauled to the final cut, if:

(1) excessively large areas of the mine perimeter would be disturbed by proposed methods for highwall reduction or regrading of box-cut spoils; or

(2) material shortages in the area of the final highwall or spoil excesses in the area of the box cut would be likely to preclude effective recontouring

c. All backfilling and grading shall be completed within 90 days after the department has determined that the operation is completed or that a prolonged suspension of work in the area would occur.

d. In all cases the final pit shall be backfilled so as to cover all exposed coal seams with at least 4 feet of nontoxic fill materials.

e. The transition from undisturbed ground shall be blended with cut or fill to provide a smooth transition in topography.

f. Stockpiles of salvaged topsoil shall be located in an area where they would not be disturbed by ongoing mining operations and would not be lost to wind erosion or surface runoff. All unnecessary compaction and contamination of the stockpiles shall be prevented; and the topsoil, once stockpiled, shall not be rehandled until replaced on regraded disturbed areas.

g. The mine operator shall take all measures necessary to assure the stability of topsoil on graded spoil slopes.

h. Any application for permit or accompanying reclamation plan which for any reason proposes to use materials other than, or along with, topsoil for final surfacing of spoil or other disturbances shall document problems of topsoil quantity or quality. The application or plan must also show that the topsoil substitute proposed:

(1) would not contribute to or cause pollution of surface or underground waters

(2) would support a diverse cover of predominantly native perennial species equivalent to that existing on the site prior to any mining related disturbance.

i. Temporary cover crops to be used must be specified and seeding rates included. If millet is to be used, its suitability should be referenced.

5. MITIGATING MEASURES (ABANDONMENT)

a. Upon abandonment of any road or railraod loop, the area shall be conditioned and seeded and adequate measures taken to prevent erosion, by means of culverts, water bars, or other devices. Such devices shall be abandoned in accordance with all provisions of Chapter 325, Session Laws of Montana, 1973, and MAC 26-2.10 (10)S-10330 and MAC 26.210(10)-S10340 of the Rules and Regulations adopted pursuant thereto. Upon completion of mining and reclamation activities, all roads shall be closed and reclaimed unless the landowner requests in writing, and the Montana Department of State Lands concurs, that certain roads or specified portions thereof are to be left open for future use.

b. In the case of abandoned roads, the roadbeds shall be ripped, disced, or otherwise conditioned before topsoil is replaced. The Montana Department of State Lands may prescribe additional alternate conditioning methods for the reclamation of abandoned roadbeds.

TABLE I-4.--Spring Creek project work force schedule

JOB CATEGORY	NUMBER EMPLOYED (By Quarter)															
	Year 1			Year 2				Year 3				Year 4				Year 5 thru 25
	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1 2 3 4
Salaried & Supervision																
Mine Manager	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Admin. Manager	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mine Supt.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Asst. Mine Supt.						1	1	1	1	1	1	1	1	1	1	1
Shift Supervisors						1	2	2	3	4	4	4	6	6	8	8
Maint. Supt.					1	1	1	1	1	1	1	1	1	1	1	1
Asst. Maint. Supt.							1	1	1	1	1	1	1	1	1	1
Electrical Supt.		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Storekeeper				1	1	1	1	1	2	2	2	2	3	3	3	3
Eng. Aide	1	1	1	1	1	1	1	1	1	1	2	2	2	2	3	3
Geologist				1	1	1	1	1	1	1	1	1	1	1	1	1
Reclamation Cord.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Safety Engr.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Training Supervisor							1	1	1	1	1	1	1	1	1	1
Secty-Clrk-Recpt.	1	1	1	1	2	2	2	2	3	3	3	3	3	3	3	3
Total - Salaried	1	13	13	15	17	19	22	24	28	29	30	30	33	34	37	37
Overburden Removal																
Dragline Operator							1	1	1	1	2	2	3	3	4	4
Shovel Operator							1	1	1	2	2	2	2	3	3	3
Driller-Shooter							2	2	2	3	4	4	5	6	6	6
Dozer Operator							1	1	1	1	2	2	3	3	4	4
Dragline Oiler							1	1	1	1	2	2	3	3	4	4
Shovel Oiler							1	1	1	2	2	2	3	3	3	3
Driller Helper							2	2	2	3	4	4	5	6	6	6
Truck Drivers							6	6	6	12	12	12	12	18	18	18
Coal Mining																
Shovel Operator								1	1	1	2	2	3	3	4	4
Driller-Shooter								1	1	1	2	2	3	3	4	4
Loader Operator							1	1	1	1	2	2	2	2	2	2
R.T. Dozer Operator								1	1	1	2	2	2	2	2	2
Shovel Oiler								1	1	1	2	2	3	3	4	4
Driller Helper								1	1	1	2	2	3	3	4	4
Truck Drivers								9	9	9	17	17	26	26	34	34
Roads, Drainage, Reclamation																
Grader Operator		1	1	1	1	2	2	2	2	2	4	4	4	5	7	7
Scraper Operator	1	1	2	2	2	2	2	2	2	2	4	4	4	4	6	6
Dozer Operator	1	1	2	2	2	3	3	3	3	6	6	6	6	8	8	8
Water Truck Drive		1	1	1	1	1	1	1	1	2	2	2	3	4	5	5
Labor		1	2	2	2	2	2	2	2	2	2	2	4	4	6	6

TABLE I-4.--Spring Creek project work force schedule--Continued

Coal Preparation and Loading																
Coal Hand. Wk. Foreman						1	1	1	1	1	2	2	3	3	4	4
Equipment Oiler						1	1	1	1	1	2	2	3	3	4	4
Coal Handler								1	1	1	2	2	3	3	4	4
Warehouse																
Supply Truck Driver						1	1	1	1	1	1	1	1	1	1	1
Helper						1	1	1	1	2	2	2	3	3	3	3
Equipment Maintenance																
Mech. Foreman						1	1	1	1	1	1	1	1	1	1	1
Mech. Wk. Foreman						1	1	2	2	2	2	2	2	3	3	3
Elect. Wk. Foreman					1	1	1	1	1	2	2	2	2	3	3	3
Weld. Wk. Foreman						1	1	1	1	2	2	2	2	3	3	3
Mechanic						4	4	7	7	8	10	12	14	16	16	16
Electrician					2	2	3	4	4	6	7	7	7	9	9	9
Welder						2	4	4	4	6	7	7	7	9	9	9
Machinist							1	1	1	1	1	1	1	1	1	1
Lube Technician							1	2	2	2	2	2	2	2	2	2
Lube Helper							1	1	1	1	2	2	4	4	5	5
Helper						3	3	4	4	6	6	6	8	10	12	12
Total -Hourly	2	5	8	8	11	29	51	73	73	97	128	130	162	187	216	216
Grand Total	13	18	21	23	28	48	73	97	101	126	158	160	195	221	253	253

CHAPTER II. DESCRIPTION OF THE ENVIRONMENT

A. GEOLOGY

1. TOPOGRAPHY AND GEOMORPHOLOGY

The topography of the Spring Creek area is typical of the northwestern Powder River Basin (fig. II-1). The area is drained by two southeasterly-flowing ephemeral streams Spring Creek and South Fork Spring Creek. The two streams join approximately 1.5 miles east of the mine area, within the borders of the proposed North Extension Decker Mine. Prominent bluffs occur along the ridge dividing the two streams and along the south valley wall of South Fork. Total relief is approximately 420 feet, the highest elevation in the area to be mined being about 3,995 feet to the northwestern end of the central ridge.

Field evidence from the mine area indicates natural rates of erosion and deposition of at least 1,200 to 2,000 tons per square mile per year (David Dossett, OSM, oral communication, 1977). This rate of erosion is attributed to the semiarid climate and a resulting limited vegetation cover, and is considered to be relatively high compared to the United States as a whole. Most erosion at the present time occurs from sheetwash; more serious forms of erosion, such as rills and gullies, have not been observed. Erosion rates have probably been accelerated by livestock grazing and by man's recent activities (primarily through off-road travel) related to coal exploration and environmental baseline studies. Erosion rates reach their greatest natural levels during spring thaw and periods of intense or prolonged rain.

2. STRATIGRAPHY AND OVERBURDEN

The Spring Creek coal field is actually a northwestward extension of the Decker coal field (Matson and Blumer, 1973). The exposed rocks consist of recent alluvium and of sediments of the Tongue River Member of the Fort Union Formation (fig. II-2). The overlying Wasatch Formation occurs at higher elevations along the southern and northwestern boundary of the permit area. The near-surface subbituminous coal beds are part of the Fort Union Formation and are named the Anderson, the Dietz No. 1 and the Dietz No. 2, respectively. In the permit area these seams merge to form a single seam averaging about 81 feet in thickness (see Chapter I for additional information). The Canyon Coal, about 19 feet thick, occurs about 106 feet below the base of the Dietz No. 2 coal seam in the permit area (fig. II-3).

Ground water aquifers beneath the permit area include the alluvium in the valley of South Fork Spring Creek, the Anderson-Dietz coal seam, and the Canyon Coal and associated sandstones (see Hydrology).

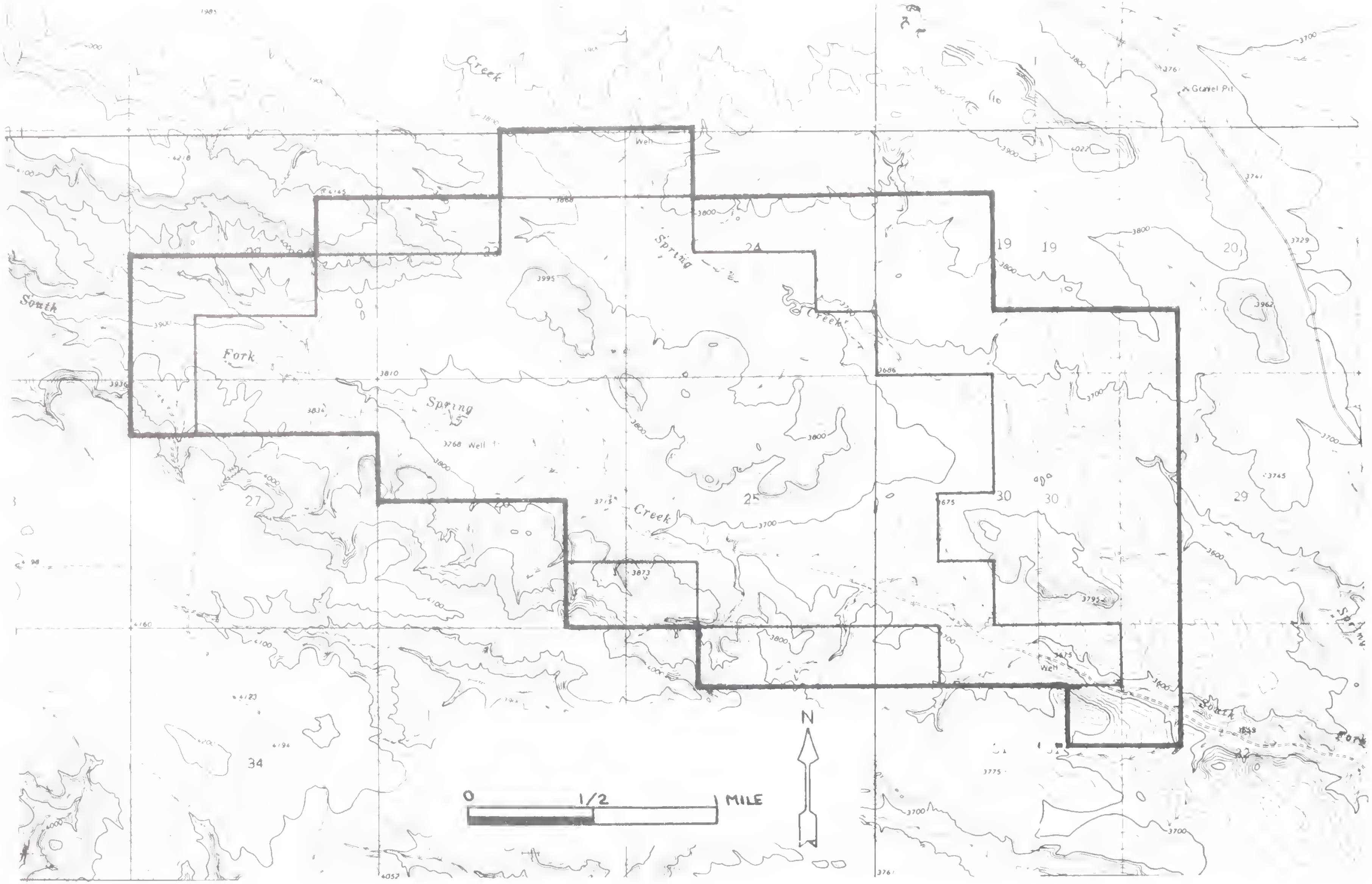


FIGURE II-1.--Topographic map of the Spring Creek area.

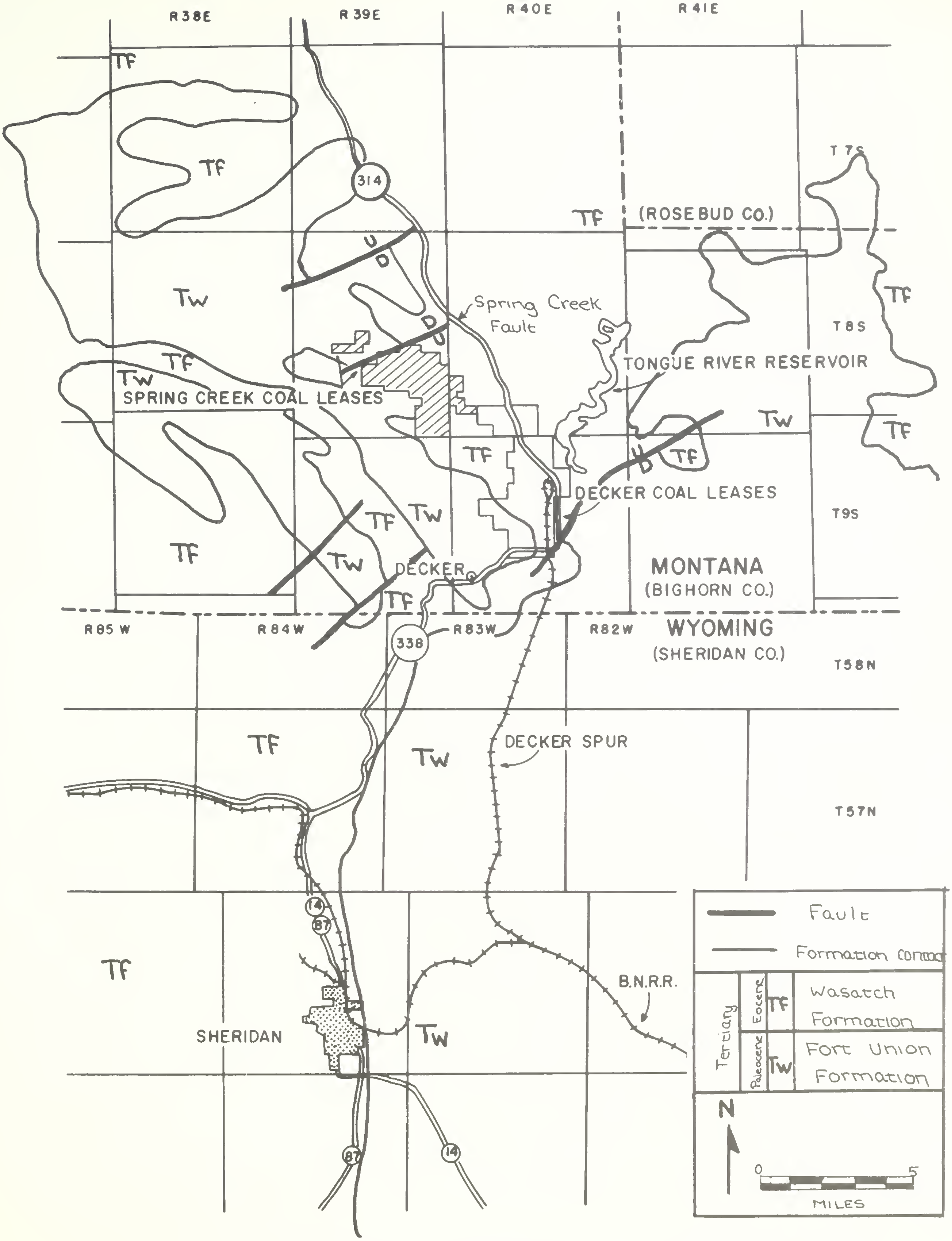


FIGURE II-2.--Regional geologic map showing the Spring Creek area.

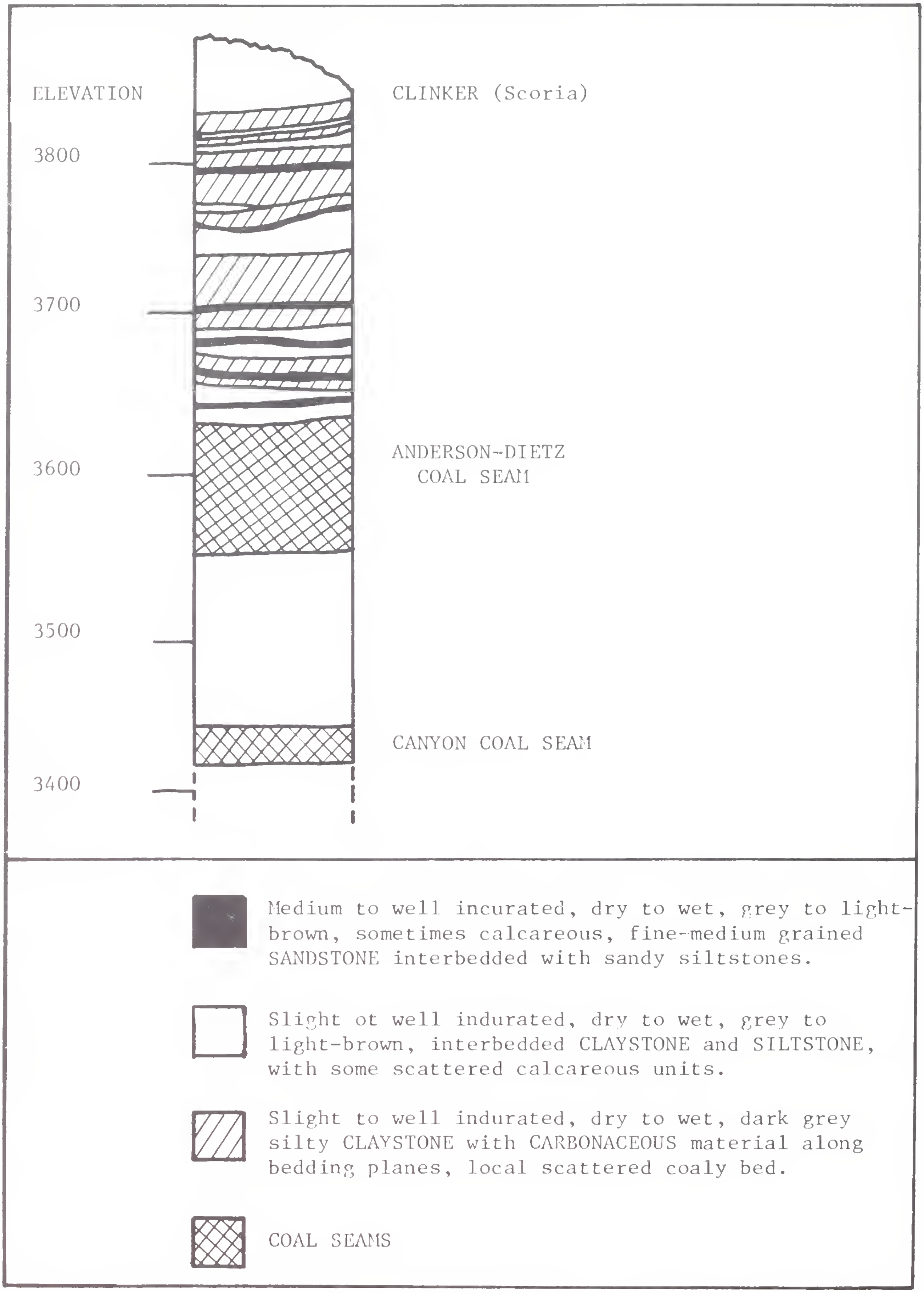


FIGURE II-3.--Geologic column of the Spring Creek coal field. All units are within the Tongue River Member of the Fort Union Formation.

The interburden between the base of the Dietz No. 2 and the Canyon Coal beds would not be affected by the proposed mining operation. Therefore this discussion will address only the overburden above the Anderson-Dietz combined seams.

Overburden in the permit area consists of discontinuous alluvium of variable thickness, along Spring Creek and South Fork, and of sandstone, siltstone, claystone, and clinker of the Tongue River Member of the Fort Union Formation. The rock units are typically grey to light-brown, clayey siltstone and grey, silty claystone beds alternating with grey-brown indurated fine-grained sandstones. Individual rock units range in thickness from less than 1 inch to 30 feet or more, and average about 5 feet. The rocks are poorly-to-well cemented, most commonly with calcite.

The clayey siltstones and claystones are generally laminated, fissile, and contain carbonaceous material scattered along bedding planes. Thin carbonaceous shales and shaley coals occur at various intervals throughout the overburden.

The overburden's minimum thickness is about 15 feet in the northern part of the permit area near the junction of the coal "burn line" and Spring Creek Fault. The maximum thickness exceeds 240 feet beneath the topographic highs in the central part of the permit area.

The company has completed geochemical and physical tests on 293 samples from 20 drill holes on the leasehold (fig. II-4). The shallowest samples were taken within a foot of the surface the deepest from less than 1 foot above the top of the Anderson-Dietz coal seam. These samples represent each change in strata (at intervals not less than 2 feet or more than 10 feet) at each drill hole.

Data describing the overburden traits are summarized in table II-1. Levels of cadmium, molybdenum, nickel, and the sodium adsorption ratio (SAR)[1] exceed the State suspect levels throughout the mine area[2]. Levels of manganese, nitrate, pH, and soluble salts vary considerably, and some portions of the overburden contain values exceeding State suspect levels. Concentrations of boron, copper, lead, mercury, selenium, zinc, and the clay content of the overburden all fall below the suspect levels. The physical and chemical characteristics of the overburden are further discussed in appendix A.

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[1]The sodium adsorption ratio (SAR) is related to the adsorption of sodium by the soil and is an index of the sodium or alkali hazard of the soil or of water used to irrigate the soil. In the computation of SAR, concentrations of constituents are in equivalents per million.

[2]State suspect levels are guidelines for various levels of chemical and physical traits of the overburden above which reclamation success is suspect.

TABLE II-1.--Overburden traits of the Spring Creek field summary of drillhole averages

Overburden Trait	Arithmetic Mean[1]	Range	State Suspect Level[2]	Comments
pH, paste	8.20	7.74-8.87	8.8-9.0	Drill hole #392 exceeds suspect level
Soluble Salts, mmhos/cm	3.82	1.37-6.62	4-6	Drill holes above suspect level identified in text
Na, meq/l	25.87	10.82-39.96		
Ca, meq/l	2.95	0.30-8.26		
Mg, meq/l	9.88	1.13-30.70		
SAR	23.29	4.34-35.32	12	Overburden mean above suspect level
ESP	13.45	3.8-25.5		
P, available, ppm	6.82	3.0-11.2		
K, available, ppm	293.39	208-343		
Nitrate, ppm	17.29	2.4-73.5	Federal livestock threshold 50	Drill holes #370 and #390 exceed suspect level
Ammonium, ppm	30.62	9.3-48.9		
B, Water soluble, ppm	0.69	0.30-1.97	8	All drill holes below suspect level
Mo, NH_4 Oxylate soluble, ppm	0.76	0.26-1.69	0.3	Overburden mean above suspect level
Se, available, ppm	0.026	0.26-1.69	2.0	All drill holes below suspect level
Cu, DTPA extractable, ppm	5.51	2.6-9.0	40	All drill holes below suspect level
Fe, DTPA extractable, ppm	343.98	140-585		
Mn, DTPA extractable, ppm	34.21	14.0-67.7	60	Drill holes #335, #370, and #382 exceed suspect level
Zn, DTPA extractable, ppm	8.77	3.14-23.17	40	All drill holes below suspect level
Ni, DTPA extractable, ppm	6.82	3.01-9.82	1	All drill holes above suspect level
Cd, DTPA extractable, ppm	0.20	0.20-0.20	0.1-1	All drill holes above suspect level
Pb, DTPA extractable, ppm	4.83	2.9-7.8	15-20	All drill holes below suspect level
Hg, Total, ppb	67.85	33.0-115.0	400-500	All drill holes below suspect level
Clay, %	28.35	24.8-37.4	40	All drill holes below suspect level

1 These values differ from those submitted by applicant which were calculated as a weighted mean.

2 These levels are intended to consider the suitability of overburden as a revegetation medium.

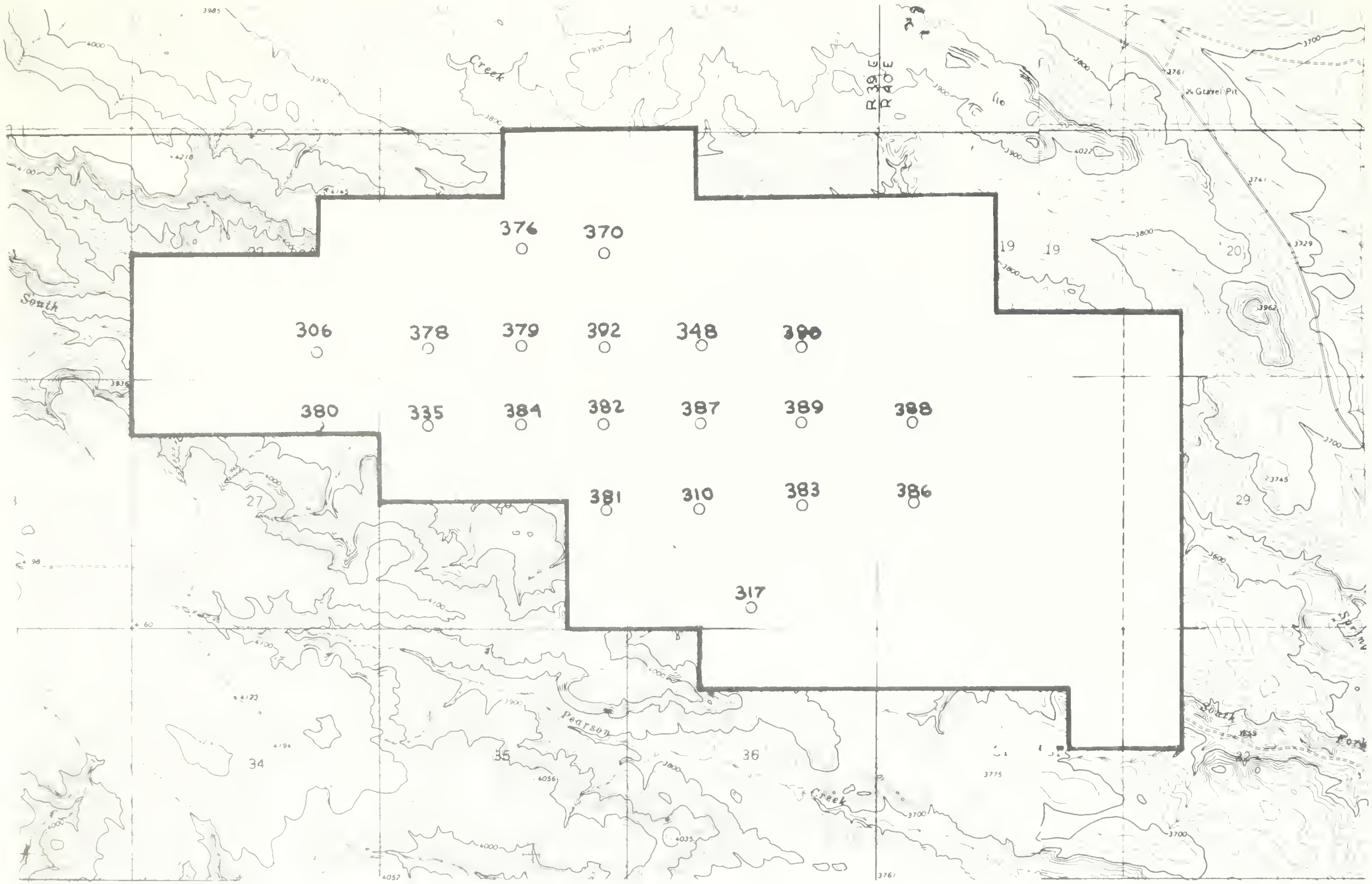

FIGURE II-4.--Locations of test holes in the Spring Creek permit area.

3. STRUCTURE

The Tongue River Member generally dips less than 1 degree to the southeast within the permit area. The beds are locally displaced by minor faults with displacements mostly less than 15 feet but ranging up to about 30 feet. Spring Creek Fault, along the northwest margin of the coal field, has a displacement ranging from 150 to about 200 feet, down to the northwest (fig. II-2).

4. MINERALS OTHER THAN COAL

Abundant quantities of clinker crop out in the permit area. Small lenses of sand and gravel occur in the alluvium of intermittant streams; they are not considered to be of significant economic value. Commercial quantities of other minerals are not known to exist within the permit area.

Nearly half the mine area is covered by oil and gas leases. No exploratory oil or gas wells have been drilled on the permit area; however, five such wells, all nonproductive, have been drilled within 2 miles of the leasehold.

5. PALEONTOLOGY

A preliminary paleontological survey was conducted by Brown and McGrew (1976) to inventory and evaluate potentially significant paleobotanical, invertebrate and vertebrate fossils located in the study area. These investigations consisted of archival review and ground surveys. No important paleontological resources were found within the study area. The fossils found were poorly preserved and/or unidentifiable, and similar plant and animal fossils are much better represented at other sites in equivalent rocks outside the study area. These results, however, do not preclude the possibility of important paleontological resources being exposed during mining activities.

B. HYDROLOGY

1. SURFACE WATER

The permit area is drained by Spring Creek and South Fork Spring Creek southeastward to the Tongue River Reservoir (fig. II-1): Spring Creek drains the northern part, and South Fork the southern part. All streams in the permit area are ephemeral; however, a short reach of South Fork is perennial, due to a spring that discharges water from the alluvium. There are several stock ponds in the watersheds of Spring Creek and South Fork which reduce runoff through the permit area. During dry periods the only water available for livestock and wildlife use is the alluvial spring and the water in one storage tank at a stock well near the west end of the permit area. Although additional sources of water are located within a few miles, those on the proposed mine site are indispensible for present use patterns.

In addition to the perennial spring, there are seven stock ponds in the permit area, two of which are partially breached, and therefore of only minor importance. The estimated combined holding capacity of all the ponds is about 25 acre-feet. However, the amount of water contained, and the length of time in which the water is held, is highly variable, depending on weather conditions during a given year: fed by runoff, the ponds generally contain water in the spring although they may be dry through the entire year.

The estimated annual runoff from the Spring Creek drainage, below the confluence of Spring Creek and South Fork, is about 460 acre-feet. Table II-2 summarizes available runoff data for the Spring Creek

TABLE II-2.--Annual peak discharge for Spring Creek near Decker, Montana

[Drainage area: 34.7 mi^2]

Annual maximum data.--

Water year	Date	Gage height (ft)	Discharge (cfs)
1958	June 7, 1958	3.4	184
1959	Mar. 17, 1959	1.19	45
1960	Mar. 19, 1960	1.31	49
1961	--	--	(1)
1962	June 16, 1962	6.59	2 900
1963	June 15, 1963	1.07	40
1964	Apr. 22, 1964	05	15
1965	Aug. 21. 1965	2.61	362
1966	Sept.26, 1966	11	2 15
1967	June 12, 1967	2.81	390
1968	June 9, 1968	72	130
1969	Mar. 18. 1969	1.82	250
1970	May 14, 1970	1.35	195
1971	Feb. 14, 1971	6.50	1,400
1972	Feb 28, 1972	2.90	420
1973	Sept. 1, 1973	.26	2 20
1974	Mar. 28, 1974	1.31	40
1975	Mar. 3, 1975	3.89	240

Annual peak discharges from small drainage areas in Montana.

1 No evidence of flow during year
2 About

drainage system as measured at the U.S.G.S. crest stage station approximately 2 miles east of the proposed mine area. Runoff results from rapid snowmelt and from intense summer thunderstorms. Peak flows have occurred as early as February 14 and as late as September 26, as indicated from records for the period 1958-77. The maximum peak discharge of 1,400 cubic feet per second probably corresponds to about a 25-year frequency flood.

Although long-term data are not available, peak discharges have been calculated for Spring Creek and South Fork near the west end of the mine area, as indicated in table II-3.

TABLE II-3.--Estimated peak discharge (in cfs) for Spring Creek and South Fork Spring Creek*

	Recurrence intervals					
	2 years	5 years	10 years	25 years	50 years	100 years
Spring Creek	75	280	500	950	1,460	2,900
South Fork Spring Creek	50	170	320	630	990	1,580

* After Johnson and Omang (1976) and Hedman and Kastner (1977).

Other calculations about 2.5 miles downstream on South Fork, have indicated a substantial loss in the reach of streams through the permit area. The loss is due in part to infiltration and to some storage in partly breached ponds.

a. Sediment

Premining natural sediment-yield rate is assumed to be 0.5 acre-foot/mi^2/yr for undisturbed land (U.S.D.A., 1974).

b. Quality

Although surface water quality on the permit area is not currently known, the water is presently being used by livestock without evident ill effects.

2. GROUND WATER

Four aquifers have been identified within about 300 feet of the surface in the vicinity of the permit area: the alluvium, the Anderson Dietz Coal the clinker, and the Canyon Coal and its associated sandstones. The horizontal movement of ground water, except for that in the alluvium, is controlled by the gentle southeastward dip, or slope, of the beds toward the Tongue River Reservoir and by the Spring Creek

Fault. The Spring Creek Fault probably inhibits movement into the area from the northwest. Thus most of the ground water in the permit area probably originates from local recharge.

The downward movement of water in the area is restricted by rocks of low permeability that make up most of the geologic section. Restriction of the downward movement results in a series of perched zones of saturation separated by unsaturated rock. It is probable, however, that fractures provide avenues of movement even through rocks of low permeability. Thus, it is believed that the four aquifers are hydraulically connected.

a. Alluvial Aquifers

Discontinuous alluvial deposits along the streams are composed of silt, sand, and gravel, with permeabilities that vary depending on the local composition. Where underlain by bedrock having low permeability, these materials are partially saturated, thus forming a local aquifer. The alluvium of Spring Creek contains water only upstream from the Spring Creek Fault; southeast of the fault, the alluvium overlies highly permeable clinker and is drained. The alluvium along South Fork contains water except where it overlies clinker in the eastern part of the area. State and Federal regulatory agencies have not determined whether the alluvial deposits in the permit area constitute alluvial valley floors, which remain to be defined pursuant to the Surface Mining Control and Reclamation Act of 1977.

The alluvium is recharged by infiltration from the ephemeral streams and is discharged by water-loving plants along the streams, by downward movement into the underlying rocks, and locally by return flow to the stream. The spring supplying perennial water to a short reach of South Fork in the permit area represents such a localized return flow.

The water from the alluvium contains substantial amounts of calcium, magnesium, sodium, bicarbonate and sulfate ions (appendix B) in concentration and proportions that make the water suitable for use by livestock and wildlife. but poorly suited for domestic or irrigation use. Several wells in the general area obtain water for livestock use from the alluvium. Two of these wells are within the area to be mined (table II-4).

TABLE II-4.--Water wells in and near the Spring Creek permit area

Township	Range	Section	Depth (ft)	Aquifer	Water level (ft)	Use of water
8 S.	39 E.	SW1/4SE1/4 22	58.9	Alluvium	18.76	Stock
8 S.	39 E.	NW1/4NE1/4 23	39.6	Alluvium	28.74	Unused
8 S.	39 E.	NW1/4NW1/4 24	218.0	Anderson-Dietz?	117.20	Stock
8 S.	39 E.	SW1/4Nw1/4 24	105.1	Anderson-Dietz?	85.05	Unused
8 S.	39 E.	NW1/4SW1/4 25	44.5	Alluvium	10.33	Stock
8 S.	40 E.	NW1/4NE1/4 25	144.6	Anderson-Dietz?	95.86	Stock

b. Anderson-Dietz Aquifer

A water table in the Anderson-Dietz coal, separated from the perched water in the alluvium, ranges from 20 feet below the top of the coal, in the east, to a few feet below the base of the coal near the center of the northwest boundary of the proposed mine near the Spring Creek Fault. The transmissivity is highly variable, from an amount too low to be measured to about 130 feet per day.

The recharge to the Anderson-Dietz aquifer is largely by downward movement, mainly through fractures, from the alluvial aquifer. The general direction of movement in the aquifer is to the east. Discharge from the Anderson-Dietz is by lateral movement into the adjacent clinker and by downward movement to the Canyon aquifer.

The water from the Anderson-Dietz aquifer is of the sodium bicarbonate type, and is similar to water from the overlying alluvium. This water, as with that from the alluvium, is usable by livestock but is poorly suited for domestic or irrigation use. No wells receive water from the Anderson-Dietz aquifer within the permit area; however, several nearby wells may obtain part or all of their water from this aquifer (table II-4).

c. Clinker Aquifer

Clinker a highly permeable rock that, in this location, was formed by the burning of the Anderson-Dietz coal, forms an aquifer which lies to the north and east of the area to be mined. Due to its high permeability and the southeastern tilt of the beds, the clinker aquifer readily transmits water out of the permit area. This aquifer is recharged by infiltration from streams, by direct infiltration from the soil zone, and by lateral movement from the Anderson-Dietz coal aquifer. The water quality is variable, depending on the source of recharge; in many places it is the best quality ground water in the vicinity. It is not known which wells obtain water from the clinker; however, it is possible that some of the wells to the north and east of the proposed mine obtain all or part of their water from this source.

d. Canyon Aquifer

The Canyon aquifer is comprised of the Canyon coal and associated sandstones that overlie and perhaps underlie it. In the northwest part of section 26, the interburden between the Anderson-Dietz and the Canyon coals is mostly sandstone; the water level in this hole is 70 feet below the base of the Anderson-Dietz coal, and 20 feet above the Canyon coal. The low hydraulic head at this point may indicate a relatively high transmissivity of the aquifer in this area.

The Canyon aquifer is recharged by downward leakage from overlying rocks and probably is discharged by upward leakage, under pressure, to the alluvium of the Tongue River. The general direction

of movement is probably to the east. The water quality is not known however, the tendency for water quality to improve with depth in the area suggests that the water is at least as good as in the shallower aquifers. No wells are known to produce water from the Canyon aquifer in the area.

C. CLIMATE

The climate in the Spring Creek area is continental steppe, typical of the Northern Great Plains. The area is semiarid, characterized by cold winters, warm summers, abundant sunshine, moderate relative humidity, and low but highly variable precipitation. Most precipitation falls during late spring and early summer as thunder storms.

The following description of climate in the area is based on a summary published by the U.S. Department of Agriculture (1937, p. 11-12)

> "Cold waves occur almost every winter with varying severity, but they are not prolonged, as a rule, and are often broken up for extended periods by warm and pleasant weather usually preceded by the occurrence of chinook winds. Occasionally a warm period is abruptly terminated by a blizzard, a condition characterized by rapidly falling temperature, high winds, snowfall, and poor visibility. Ordinary outdoor occupations may be carried on during the winter with little inconvenience. Late freezing weather and snowfall in May, and in a few districts as late as June, at times lengthen the winter and delay the onset of spring.
>
> "The warm days of summer are tempered by cool nights. While the summer season is usually short, it is made up to a large extent by the long days of abundant sunshine, which, aided by moderately high altitude and a clear, thin atmosphere, rapidly promotes crop growth and largely accounts for the high nutrient quality of the grains and grasses grown here. The cool nights materially help to protect against grain rust. The "chinooks", which are welcome in winter, sometimes become the hot parching winds of summer that bring about a rapid deterioration of grain crops and range grasses within a few days....Dry fall months usually occur with no severely cold weather until December. The prevailing dryness of the air greatly lessens the discomfort of very cold or hot weather, when compared with the same or less extreme temperatures in more humid sections of the country."

2. SUBREGIONAL CLIMATIC FACTORS

a. Precipitation

Precipitation data are available from three stations (fig. II-5). Precipitation at the leasehold is best characterized by the Decker weather station, 11 miles south. The annual average precipitation at Decker is approximately 12.23 inches (average from 1950-1976). Forty-five percent

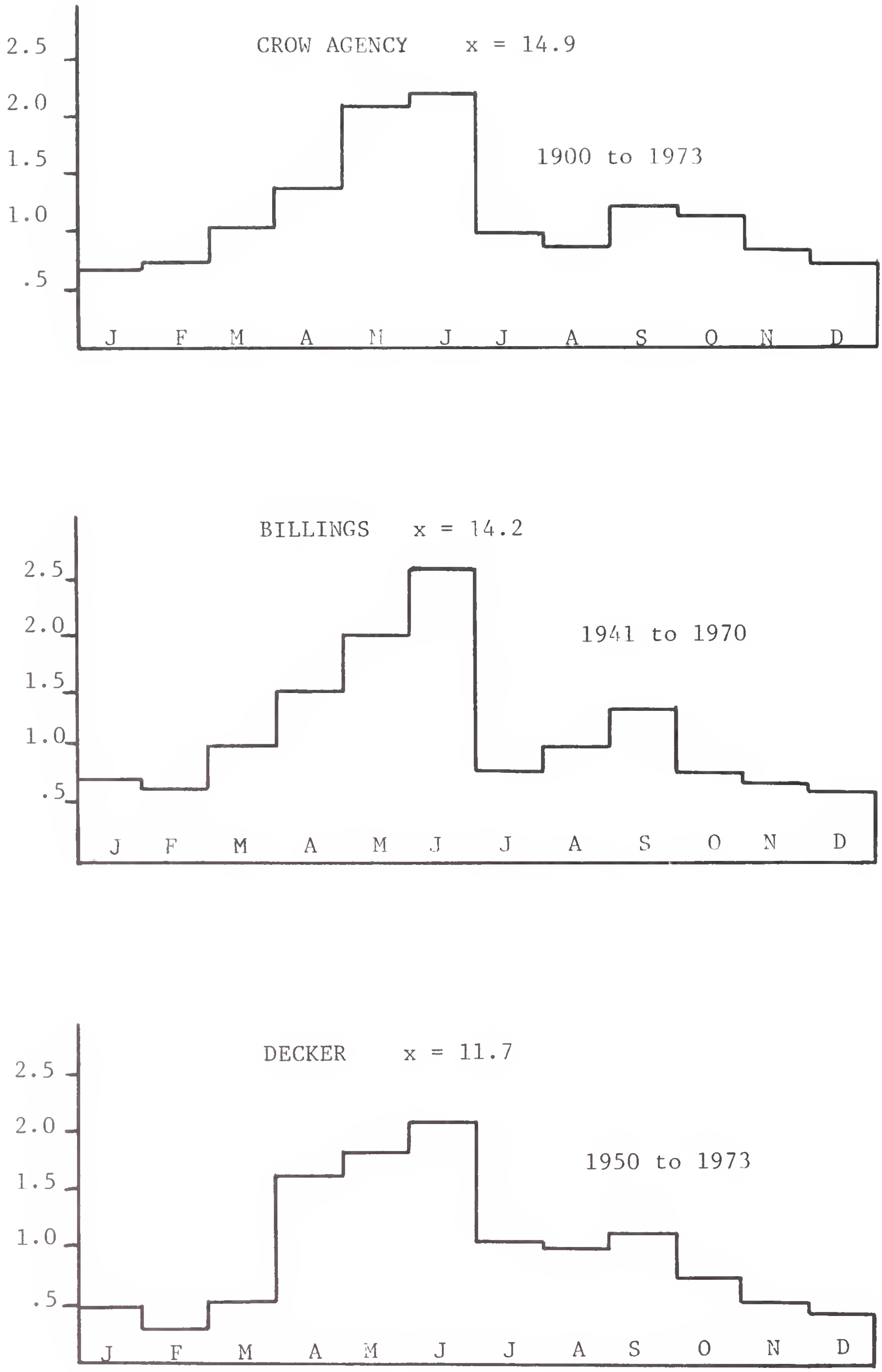

FIGURE II-5.--Annual precipitation profiles.

of the precipitation in this area occurs between April and June with an additional 25 percent during the remainder of the growing season, until approximately September 30 (fig. II-5). On the average, precipitation occurs on 70 days of the year and on 49 of these days (13.4 percent of the year) the amount of precipitation is 0.10 inch or more.

Most of the spring and summer precipitation occurs as thunderstorms, occasionally accompanied by hail and high winds. The heaviest 24-hour storm recorded at Crow Agency was 3.02 inches in August 1964; at Billings, 4.68 inches in April 1941; and at Decker, 3.30 inches in June 1968. Return rates for storms of this magnitude are shown in table II-5. A storm of over two inches can be expected to occur every ten years in the vicinity of Decker. Such storms represent a significant portion of the annual precipitation. Such large amounts of precipitation over such a short time period have a very significant impact on erosion, sedimentation rates, and reclamation (see Soils, Geomorphology, and Vegetation).

TABLE II-5.--Probability of large precipitation events
[U.S.D.C., 1973]

	Return Period (yr.)					
	2	5	10	25	50	100
Precipitation (inches)	.4	1.9	2.2	2.7	3.0	3.4

Long-term precipitation records at Billings reflect the variability in precipitation of the area. Both the Billings and the Decker weather data illustrate that the last decade has had above average precipitation (fig. II-6). The long-term cycle illustrates that below average precipitation can be expected some time in the next 20 years.

b. Temperature

Although temperatures do not vary widely throughout the permit area, the diurnal and seasonal variations are large. Daily temperatures may be expected to range from -13° F in winter, to 100° F in summer. The mean annual temperature is 46° F. The warmest month is July with an average temperature of 71.5° F and the coldest month is January with an average temperature of 19.2° F. The diurnal temperature variation during both summer and winter can be greater than 40° F.

The frost-free period (growing season) at Decker is estimated to be 90 to 110 days (U.S.D.A., 1972).

c. Wind

Wind data from Spring Creek shows that the dominant surface airflow is from the northwest, down valley (fig. II- 7). The airflow pattern is topographically influenced and is channeled along the valley

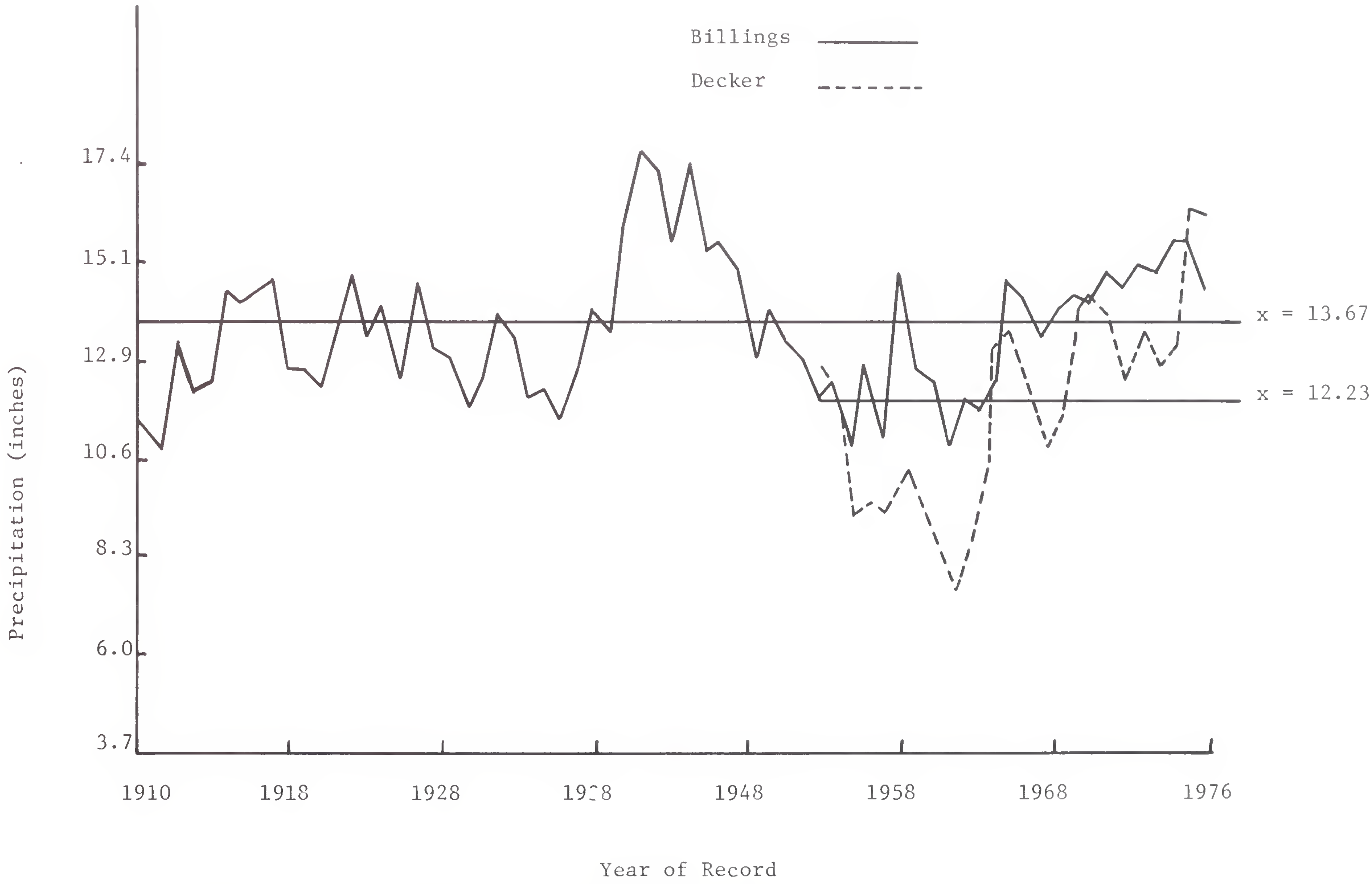

FIGURE II-6.--Three-year running averages of precipitation, Billings and Decker.

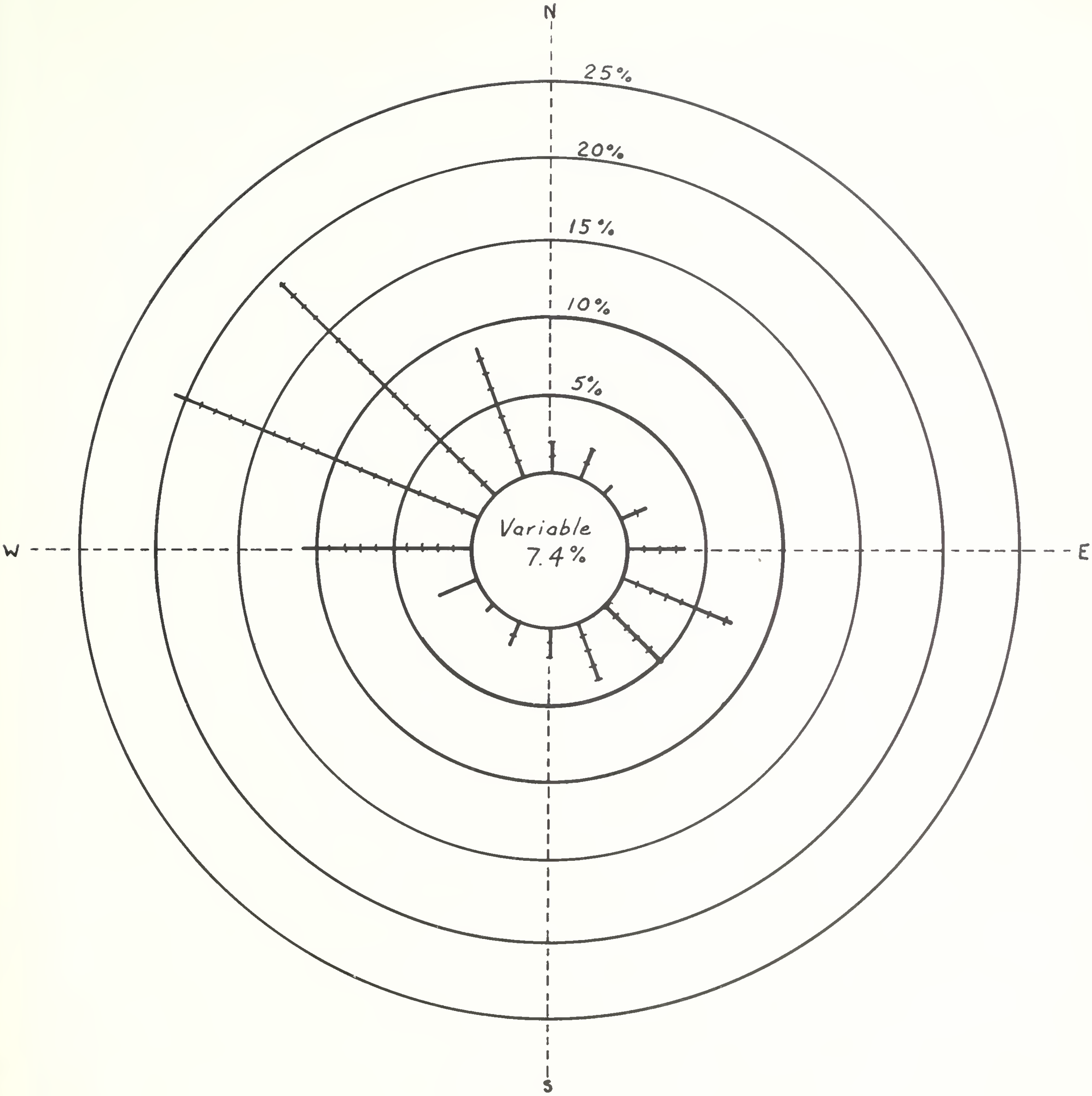

FIGURE II-7.--Annual wind rose diagram for Spring Creek.

axis of Spring Creek. Downvalley flow is dominant, however, some up-valley flow occurs during the day and is generally light. The average wind speed at Spring Creek is approximately 7 mph.

d. Microclimate

Microclimates are climatic conditions shaped by small localized topographic, geologic, and vegetative patterns. Those aspects of special concern are temperature, moisture, wind, and solar radiation all of which are affected by the physical characteristics of a site (slope, aspect, elevation, drainage pattern, soil type, etc.). Microclimates include all localized conditions occurring within a few feet (above and below) the soil surface. The biotic and abiotic factors interact to create a microclimate unique to each site and to create a diverse vegetation mosaic at Spring Creek (16 vegetation communities exist).

D. AIR QUALITY

The Spring Creek area, predominantly upwind of the Decker mining complex, is considered to have pristine air quality. Measured concentrations of total suspended particulates (TSP) and settled particulates on the permit area are well within Federal standards and Montana state guidelines. Gaseous pollutants and visibility characteristics similarly reflect clean air. The Spring Creek area is a "PSD (Prevention of Significant Deterioration) Class II" airshed, a classification which means that although there is no legal requirement to maintain its pristine air quality, excessive degredation would be prohibited.

Three high-volume air monitoring stations are in the Spring Creek vicinity (figure II-8). Air sampling results for atmospheric particulates are tabulated in appendix D-1.

The geometric mean for total suspended particulates (TSP), based on 24-hour arverage concentrations (measured every sixth day) at the Spring Creek station, was 21.1 ug/m^3 with a 24-hour maximum concentration of 47.2 ug/m^3 (table II- 6). At Youngs Creek the geometric mean was approximately 9 ug/m^3 with a 24 hr. maximum of 50 ug/m^3. Both sites are below the Federal standards of 75 ug/m^3 annual geometric mean and 150 ug/m^3 24-hour maximum and Montana State guidelines of 75 ug/m^3 annual geometric mean and 200 ug/m^3 24-hour maximum for both the annnual geometric mean and the 24-hour maximum.

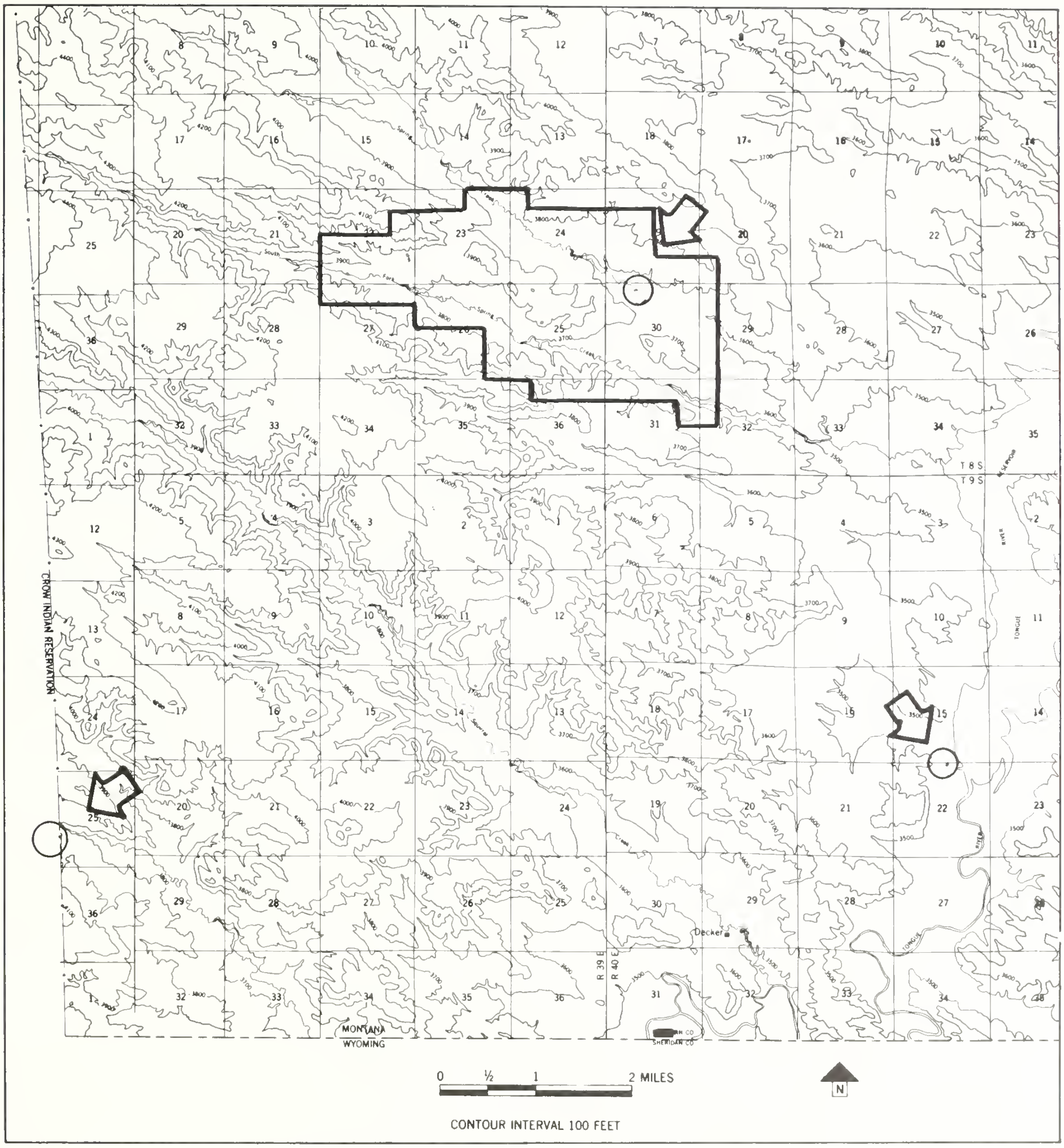

FIGURE II-8.--Air monitoring stations in the Spring Creek area.

TABLE II-6.--Total suspended particulate (TSP, ug/m^3) and settled particulate (dustfall, tons/mi^2/month) data characteristic of Spring Creek and vicinity

SITE	MONITOR	PERIOD OF RECORD	GEOM.	ARITH.	MAX.	MIN.
Spring Cr.	TSP	05/18/76 to 02/12/77	21.1	---	47.2	---
Youngs Cr.	TSP	10/03/75 to 02/12/77	8.6	---	50.0	---
Decker	TSP	01/09/76 to 11/20/76	74.1	---	236.2	---
Youngs Cr.	Dustfall	9/74 to 1/76	---	5.71	9.51	0.51

Dustfall, a measure of "settleable particulates" was measured at Youngs Creek, a similarly undisturbed area. The average value recorded was 5.71 tons/mi^2/mo. (the Montana residential standard is 15 T/mi^2/mo.). These concentrations ranged from 9.51 tons/mi^2/mo. to 0.51 T/mi^2/mo. These values are low average when compared to similar undisturbed sites in eastern Montana.

Concentration of gaseous emissions, such as sulfur dioxide (SO_2), nitrogen oxides (NO_x), and carbon monoxide (CO), at Spring Creek are unknown. Air quality studies from similar sites in eastern Montana report 24-hour maximum concentrational ranges of 0.0 to 43.0 ug/m^3 for SO_2 (Federal standard is 365 ug/m^3 and State guideline is 260 ug/m^3) and 0.0 to 19 ug/m^3 for NO_2 (no standard) with annual arithmetic means ranging from 0.29 to 9.0 ug/m^3 for SO_2 (Federal standard is 80 ug/m^3 and State guideline is 52 ug/m^3) and from 1.6 to 2.7 ug/m^3 for NO_2 ug/m^3 (Federal standard is 100 ug/ m^3) (EPA, 1975; Gelhaus, 1976). All concentrations at Spring Creek are assumed to be well within Federal standards and Montana state guidelines because of a lack of significant sources.

Visibility at Spring Creek is probably similar to that at Youngs Creek, usually about 35 miles (see appendix D-2).

The importance of additional baseline air quality parameters, such as particle size distribution and chemical composition are discussed in Chapter III.

E. SOILS

1. THE SOIL RESOURCE

The soils in the Spring Creek area reflect the diversity of their parent materials, vegetation, topography, age, and, to a lesser degree, the influence of man's activities. Although the natural rates

of erosion are high relative to more temperate areas, the soils have been in a state of semiequilibrium, in which apparent rates of soil formation compensate for erosion over the long term.

The diversity of soils in the permit area reflects the relative stability of the ecosystem as a whole. The soils have developed a range of chemical and physical characteristics, supporting a wide diversity of vegetation, and in turn, many forms of animal life. By contrast, uniform areas reclaimed after mining, such as those at West Decker and Colstrip, do not support the diverse life forms represented in the permit area.

Within the permit area, approximately 250 acres have been cultivated at some time in the past. In those formerly-cultivated areas, vegetation cover has been reduced and erosion rates increased, both by unknown amounts. Most of the remaining 4,170 acres within the permit area have been impacted to a lesser, unquantified degree by overgrazing during the last 100 years. Recovery rates from overuse on old fields and pasturage appear to be very slow.

Soils within the Spring Creek area are not well developed compared to soils formed in somewhat wetter areas. Soils series mapped within the Spring Creek area are included in three Orders: Aridisols, Mollisols, and Entisols. Subgroup classifications of soil series and complete profile descriptions are in appendices E-1 and E-2, respectively and should be consulted along with the chemical and physical data in appendix E-3, to develop an accurate image of the soils in the permit area. Figure II-9 illustrates the location and distribution of the various series and associations mapped within the Spring Creek area. All information has been provided by the company and has been field checked and subsampled by soil scientists from the Montana Department of State Lands and the Northern Powder River Basin Task Force. Minor revisions are being prepared by the company's consultant.

The moderately well developed Aridisols include the Colbar, Corkim, and Kimlen series, and are characterized by moisture regimes marginal-to-aridic which provide moisture at a time when the soil is warm (late spring, early summer). The "B" horizon is altered (cambic) but not otherwise developed. These soils are further characterized by accumulations of soluble salts below 30 inches, making this zone saline and unsuitable for reclamation use.

The Mollisols, less well developed than the Aridisols, include the Erlan and Sperlin series. These soils are characterized by dark-colored surface horizons denoting accumulations of organic matter, and a cambic, or having the appearance of a cambic, "B" horizon.

Salt accumulation is variable in the Mollisols, and appears to be at least partially dependent upon subsurface textures and slope position. Soils with coarser textures and higher rates of inflow will have deeper accumulations of salts than heavier, drier soils. (compare

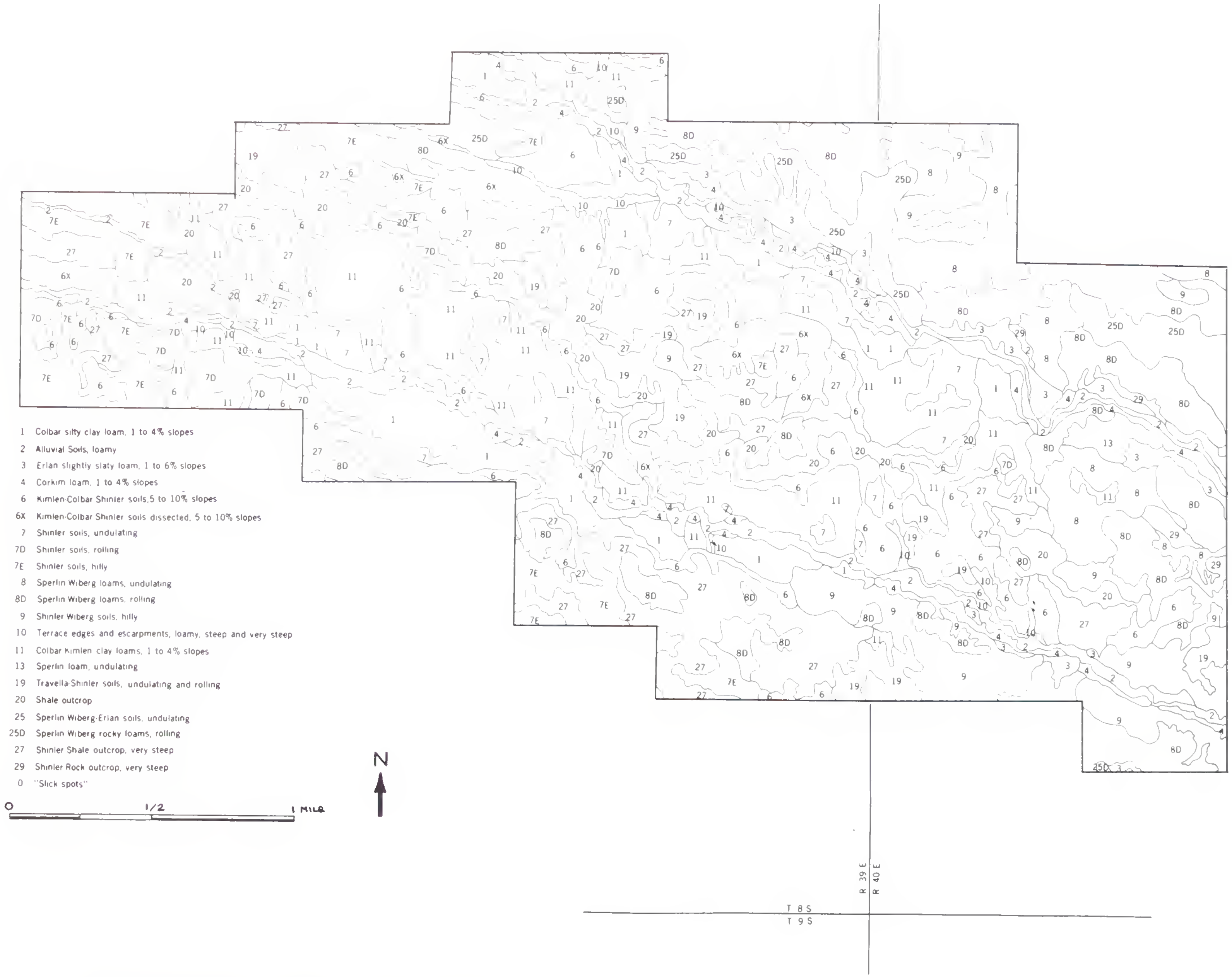

FIGURE II-9.--Soil series and associations mapped in the Spring Creek permit area.

Erlan and Sperlin electrical conductivity values and silt and clay percentages, appendix E-3).

Entisols are noted principally for their lack of development. These include the Shinler, Travella and Wiberg Series, as well as the otherwise undifferentiated alluvial soils. Maximum depth of development in these series is 12 inches, and is limited to surface "A" horizons. The alluvial soils may include soils which could be classified as Mollisols. Based on available data and field observations, it is anticipated that Entisols would not be suitable to extensive salvage for reclamation purposes. There are several small areas in which upwards of 12 inches are available. The presence of bedrock near the surface is the principal limiting factor. Salt accumulations are concentrated below the soil profile in most cases. The alluvial soils may be an exception, but chemical and physical characteristics have not been submitted by the company for these soils.

2. CURRENT AND POTENTIAL USE

All of the Spring Creek area has been used for grazing in the recent past. At some time, there were attempts at both irrigated and dryland farming on approximately 250 acres, mostly Colbar and Kimlen soils, but these activities apparently were abandoned in the 1930's.

Soils in the area are capable of a more intensive use than has historically been the case, assuming high levels of management. Although the soils mapped by the company's consultant are not in the National Cooperative Soil Survey, efforts have been made to employ the Land Capability Classification System used by the Soil Conservation Service (SCS). This has been done by correlating the known characteristics of the soils with established series which have been classified in capability classes. Table II-7 details the soil mapping units by area and capability class (fig. II-10).

Capability Classes IIIe and IVe are considered potentially usable for crop production, with careful management. Approximately 1,965 acres (44.5 percent) of the area falls within these classes. Classes VIe and VIIe (46.4 percent), are best suited for grazing and wildlife with the exception of 350 acres (9.1 percent) of very steep and rocky terrain in Class VIIIe. These soils are designated as best used for wildlife, watersheds, and esthetic enjoyment.

F. VEGETATION

Vegetation in the Spring Creek area is representative of that in the breaklands and ephemeral stream courses throughout much of southeastern Montana. The species composition of this area typifies the western extension of the Northern Great Plains region, although species also occur in the Palouse Prairie or Great Basin Regions. The occurrence and distribution of the flora reflect regional and local geologic and topographic features, and the resulting edaphic, climatic, and

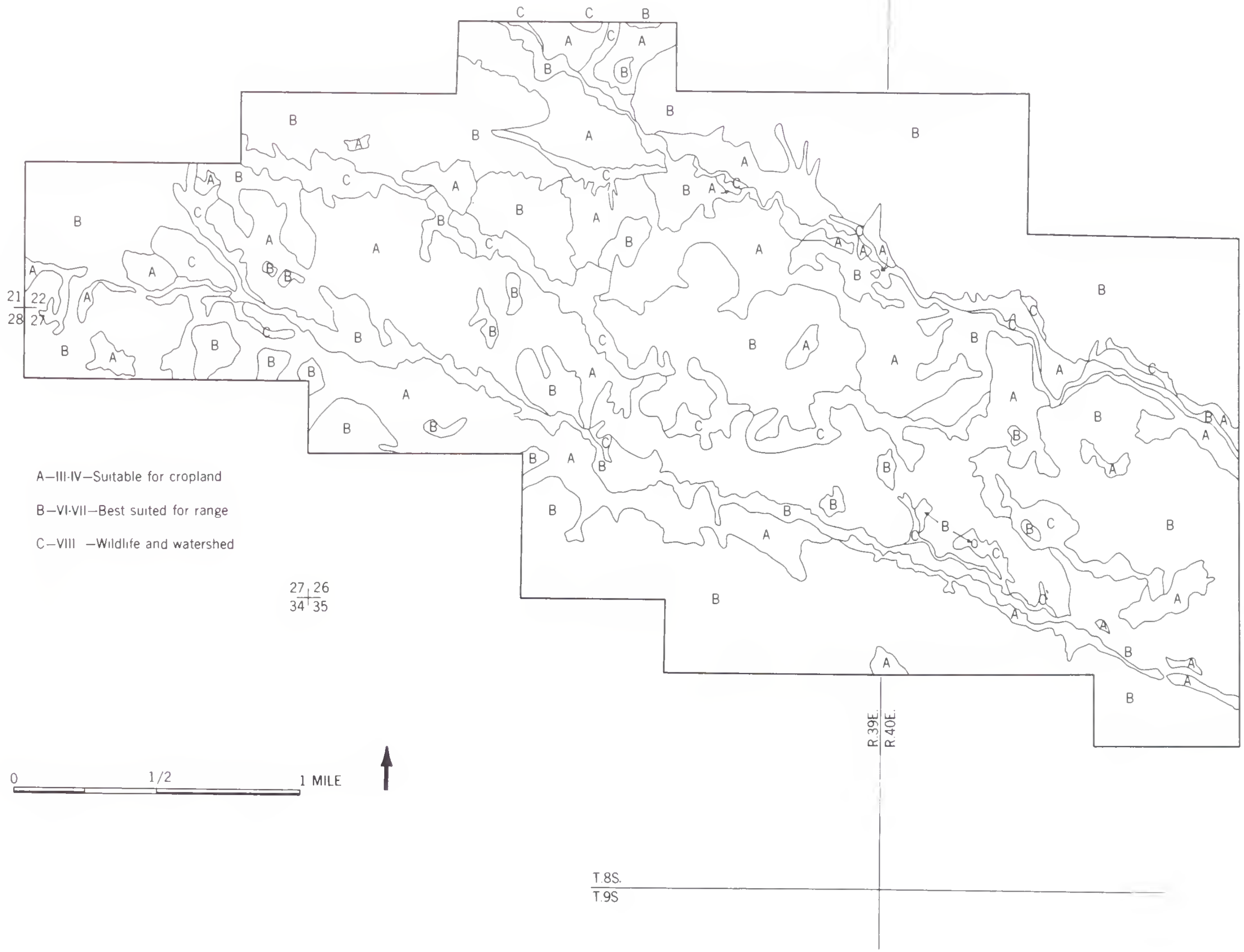

FIGURE II-10.--Map showing land capability classes, Spring Creek permit area.

TABLE II-7.--Land capability classes of soils mapped in the Spring Creek permit area

Capability Class 1/	Soils Map Unit 2/	Soil Series name & description (Subgroup to which series belongs)	Parent material and typical physiographic location	Depth to Bedrock (inches) 3/	Slopes (%) 4/	Total Acres	% of Total Acres	Remarks 5/
IIIe	1	Colbar; fine, silty clay loam (Ustollic Camborthids)	alluvium/colluvium on terraces & fans	>66	1-4	254	5.7	Soils in class III have severe limitations that reduce the choice of plants, require special conservation practices, or both, when cultivated. They are suited for cultivated crops, pasture, range and wildlife.
	11	Colbar-Kimlen; fine, clay loam (Ustollic Camborthids)	(as above)	42-66+	1-4	600	13.6	
	3	Erlan; coarse, slaty loam (Aridic Haplustolls)	clinker & porcellanite footslopes below ridges	72	1-6	40	0.9	
IVe	4	Corkim; fine, silty loam (Ustollic Camborthids)	alluvium/colluvium on terraces and fans	96	1-4	69	1.6	Soils in Class 4 have greater limitations and hazards than Class 3. Still more difficult or complex measures are needed when cultivated. They are suited for growing cultivated crops, pasture, range, and wildlife.
	6	Kimlen-Colbar-Shinler*; fine clayey & silty loams (Ustollic Camborthids, Ustic Torriorthents*)	colluvium/alluvium on fans and terraces	40±20	5-10	559	12.6	
	2	Alluvial soils, loamy (Ustic Torrifluvents)	alluvium in floodplains	60	1-10 (variable)	207	4.7	
	8	Sperlin-Wiberg; coarse to fine silty loam (Ustic Torriorthents)	clinker & porcellanite on ridges and uplands	20-40	3-8 (undulating)	236	5.3	
VIe	6X	Kimlen-Colbar-Shinler (as above)	colluvium/alluvium/and bedrock on dissected fans and terraces	0-60 0-66+	5-10+	167	3.8	Soils in Class 6 have severe limitations or hazards that make them unsuited for most cultivation. They are suited generally for pasture, range, woodland & wildlife.
	7	Shinler; fine, silty clay loam (Ustic Torriorthents)	sandstone, siltstone & shale in dissected fans and terraces	4-20 (shallow)	2-8+ (undulating)	178	4.0	
	13	Sperlin; coarse to fine silty loam (Ustic Torriorthents)	clinker & porcellanite on ridges, stream divides	<20-40	2-6 (undulating)	12	0.3	
	19	Travella*-Shinler; (Lithic Ustic Torriorthents*; Ustic Torriorthents)	hard sandstone, siltstone and shale on ridge crests & broad upland surfaces	<10-20 (shallow)	2-16	219	5.0	
	25D	Sperlin-Wiberg; coarse, fragmental, to fine, silty loam (Ustic Torriorthents)	(as above) on dissected & sloping terrain	(as above)	10-25 (rolling)	23	0.5	
	8D	Sperlin-Wiberg; (same as 25D) (Ustic Torriorthents)	(as above)	(as above)	10-25 (rolling)	190	4.3	
VIIe	7D	Shinler; silty clay loam (Ustic Torriorthents) (Us	sandstone, siltstone, & shale on upland surfaces and dissected upland slopes	4-20 (shallow)	8-20 (rolling)	121	2.7	Soils in Class 7 have very severe limitations or hazards that make them generally unsuited for cultivation. They are suited for range, woodland and wildlife.
	7E	Shinler; (as above)	(as above)	(as above)	20-50 (hilly)	381	8.6	
	27	Shinler; (as above) & shale outcrops (similar to 29, in Class VIII, below)	sandstone, siltstone & shale in steep, dissected slopes	0-20 (very shallow)	100± (very steep)	554	12.5	
	9	Shinler-Wiberg; coarse, fragmental, "channery" loams (Ustic Torriorthents)	sandstone, siltstone, shale, clinker & porcellanite in dissected slopes & ridge tops	4-20 (shallow)	25-50 (hilly)	207	4.7	
VIIIe	29	Shinler & rock outcrop; (similar to unit 27 above)	Bedrock outcrops of sandstone, siltstone, and shale	0-20	60-100+ (very steep)	6	0.1	Soils and land forms in Class 8 have limitations and hazards that prevent their use for cultivated crops, pasture, range, or woodland. They may be used for recreation, wildlife and water supply.
	20	Shale outcrop	Bedrock outcrop	0	60-100+ (v. steep)	334	7.6	
	10	Terrace edges & escarpments (not classified as to capability but topographically best suited for wildlife and watershed)	Alluvium/colluvium, and bedrock	---	50-100+ (steep & v. steep)	63	1.4	

1/ Soil Conservation Service Classification - capability classes III & IV have potential for use as cropland. Capability classes VI and VII are vest suited for rangeland. Capability class VIII must be used only for wildlife or watersheds.
2/ Map units shown in figure II-9.
3/ Depths are variable; typical averages or ranges are given.
4/ The terms undulating, rolling, hilly, and very steep are used in the map explanation, figure II-9.
5/ The capability classification is a practical grouping of soils. Soils and climate are considered together as they influence use, management, and the kinds of crops that can be grown. Capability classes are also divided into subclasses. These show the principal kinds of problems involved. The subclasses are: "e" for erosion, "w" for wetness, "s" for shallow or stoney, and "c" for climate, short season or drouth conditions.

microclimatic conditions. Grazing, fire, and cultivation of the land have also influenced plant distribution. Appendices F-1, F-2, and F-3, give the species list, community productivity, and community composition by increasers, decreasers , and invaders.

1. VEGETATION MOSAIC

Four growth forms (physiognomic categories) occur within the permit area: scrub, grassland, steppe, and forest. Each category is composed of certain vegetation types; and in turn, each type is composed of certain vegetation communities. Eight vegetation types encompassing 16 vegetation communities exist within the permit area (table II-8 and fig. II-11). Communities are not haphazard in their distribution, but instead are correlated with recurring combinations of environmental situations that tend to form a pattern or mosaic. Table II-9 shows the vegetation communities and the soils on which these communities occur.

a. Forests

Generally, the Spring Creek area is too dry for ponderosa pine. However, noncommercial stands of pine occupy steep, sheltered north slopes and canyons which have thin soils underlain by fractured bedrock. These sites receive additional moisture by runoff accumulation. The inclusion of Rocky Mountain juniper into the ponderosa pine/juniper community generally makes the pine distribution appear more widespread. Rocky Mountain juniper has a greater distribution; fire and grazing appear to be the major limiting factors while depth of soil and precipitation are less important. Understories of the ponderosa pine/ juniper community include several of the other community types which occupy the shallow upland soils.

Broadleaf deciduous trees in the permit area are sparse, occuring only along a short reach of South Fork Spring Creek where ground water in the alluvium is abundant. This forest type represents a small fraction of the more general riparian community.

b. Scrub

The scrub type includes eight diverse vegetation communities, all visually dominated by certain shrub species. Of these eight, five of the communities are dominated by evergreen shrubs (four big sagebrush communities and one silver sagebrush community), and three are dominated by winter deciduous shrubs (one skunkbush community; one shadscale saltbush community; and one riparian community including chokecherry, common snowberry, prairie rose, golden current and redshoot gooseberry). Over 40 percent of the area is covered by big sagebrush communities. Overgrazing has been the most important factor in the promotion of these communities. Fire and excessive soil moisture are antagonistic to big sagebrush communities. A recent fire has eliminated the big sagebrush in the NE1/4 sec. 29, T. 8 S., R. 39 E.; however, remnants of shrubs are evident. Alluvial floodplains generally are void of big sagebrush.

TABLE II-8.--Physiognomic classes and associated vegetation communities of the Spring Creek area

Physiognomic class	Vegetation type[1] (acreage)	Vegetation: Community	Acreage[2]	Percent
Forest------	Ponderosa pine/ juniper (146)	Ponderosa pine/juniper	[3]146	3
Scrub-------	Big sagebrush/ grassland (2,323)	Big sagebrush/mixed grass	2,126	48
		Big sagebrush and-thread	12	[4]Tr.
		Big sagebrush/bluebunch wheatgrass	143	3
		Big sagebrush/western wheatgrass	42	1
	Silver sagebrush (137)	Silver sagebrush	137	3
	Riparian (16)	Riparian	16	Tr.
	Upland shrub (104)	Skunkbush	31	1
		Shadscale saltbush	73	2
Grassland---	Grassland (984)	Mixed grass	527	12
		Western wheat grass	48	1
		Needle-and-thread	16	Tr.
		Blue grama	4	Tr.
		Giant wildrye	8	Tr.
		Weed	381	9
Steppe------	Grass/half-shrub/ forb (GHF) (854)	Grass/half-shrub/forb	854	19
		Total--------	4,418	99

[1]Vegetation types generally conform to the wildlife habitat types.
[2]Acreages are extrapolated from company data.
[3]The ponderosa pine/juniper community acreages are not computed in the total acreage figure.
[4]Tr. (trace) indicates communities that cover less than 1 percent.
[5]The GHF vegetation type is included in the wildlife grassland habitat type.

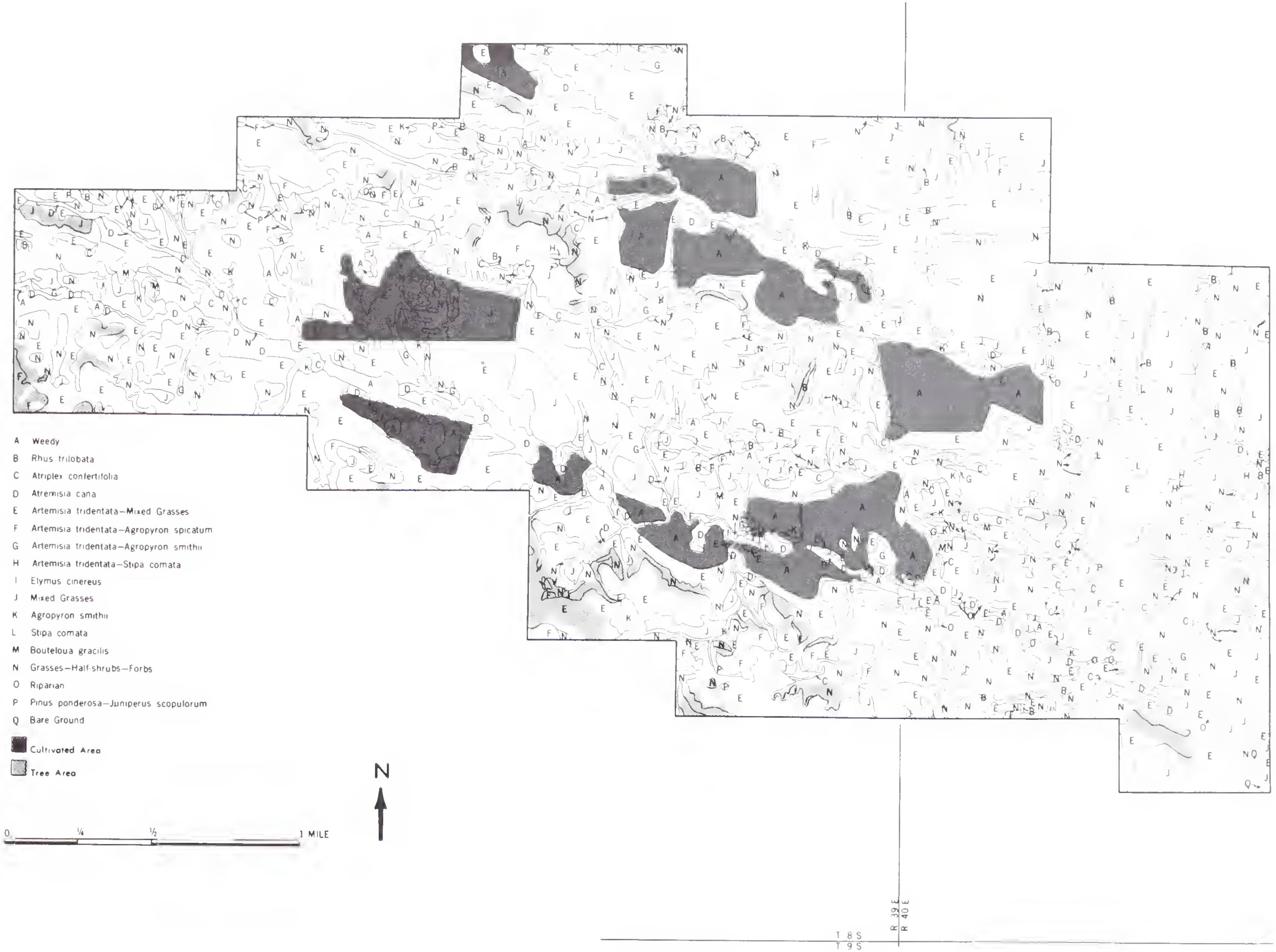

FIGURE II-11.--Map of vegetation communities, Spring Creek permit area.

TABLE II-9.--Plant communities and associated soils

Community	Soil Series	Range of Slopes	Map Unit
Silver sagebrush	Miscellaneous	5% - 10%	20
Ponderosa pine/ juniper	Shinler, Travella	2% - 50%	9,19,27, 7E,20
Shadscale saltbush	Miscellaneous, Erlan, Sperlin	1% - 40%	2,3,8D
Giant wildrye	Miscellaneous	1% - 4%	2
Riparian	Colbar, Alluvial	1% - 10%	11
Big sagebrush/ western wheatgrass	Colbar, Kimlen	1% - 10%	1,6
Western wheatgrass	Colbar, Corkim, Kimlen, Sperlin	1% - 40%	1,4,6,8D
Big sagebrush/ needle-and-thread	Erlan, Kimlen, Sperlin	1% - 40%	3,8,6X
Needle-and-thread	Erlan, Kimlen, Sperlin	1% - 40%	3,13,6X
Skunkbush	Erlan, Travella,Sperlin	1% - 40%	3,19,8D
Blue grama	Kimlen, Travella	1% - 16%	6,19
Weed	Colbar, Corkim, Erlan, Kimlen, Travella, Miscellaneous	1% - 16%	1,11,6, 19,2,4, 10,6X,3
Grass/half-shrub/ forb	Colbar, Erlan, Kimlen, Shinler, Sperlin, Travella, Miscellaneous	1% - 50%	9,6,7D,3,27, 1,8,6X,19, 7E,8D,20,25
Mixed Grass	Colbar, Erlan, Kimlen, Shinler, Sperlin, Travella, Miscellaneous	1% - 50%	6,19,20,7, 25D,1,7D,8, 9,8D,7E,3,25
Big sagebrush/ mixed grass	Colbar, Erlan, Kimlen, Shinler, Sperlin, Travella, Miscellaneous	1% - 50%	6,1,11, 27,19,2,8, 6X,3,8D
Big sagebrush/blue-bunch/wheatgrass	Colbar, Kimlen, Shinler, Sperlin, Travella	1% - 50%	6,11,27,8D, 9,19,7E

The silver sagebrush community occupies the alluvial floodplains and terraces. Soil-moisture conditions are quite good throughout the growing season. The dominant native grass within the community is western wheatgrass although needle-and-thread is occasionally equally abundant.

Of the three deciduous shrub communities in the permit area, the skunkbush community is the most extensive. Skunkbush is primarily confined to shallow and bedrock soils in drier situations, that is, steep slopes with generally a south aspect. The predominant grass in this community is bluebunch wheatgrass although needle-and-thread may be equally abundant. Skunkbush is an important browse species for mule deer; however, cattle also utilize much of the annual leader growth.

Shadscale saltbush is intermediate among the deciduous communities in terms of distribution. This community occupies steep slopes having shallow-to-bedrock soils and a saline and/or alkaline environment. Moisture conditions in these sites are quite severe thus reducing competition from many other species. This community has very wide-open canopy with as much as 90 percent bare ground. A sparse grass cover comprised mainly of bluebunch wheatgrass is found in the community.

The riparian community is very limited in the Spring Creek area. This community occupies the floodplains immediately adjacent to the ephemeral stream channels. Many of the shrub species and deciduous trees are utilized by wildlife as a food source, nesting areas, and shade. Giant wild rye is the dominant grass within this community.

c. Grassland

Five communities comprise the grassland type which have a history of disturbances, generally from grazing. The communities reflect this disturbance by their distribution and species composition.

The most widespread of the five is the mixed-grass community. It is not associated with any particular soil type, slope, or aspect, and may actually represent the intergradation of several historically dissimilar communities (dominated by different grass species). This community, with the big sagebrush/mixed-grass community, accounts for over 60 percent of the vegetation cover in the Spring Creek area. Species diversity in the mixed grass community is quite high.

The western wheatgrass community has a limited distribution in the Spring Creek area primarily because of overgrazing. Where it occurs this grass may be the predominant species.

Needle-and-thread grassland shows an affinity for moderately-deep to deep soils. As for the western wheatgrass communities, present day distributions of needle-and-thread dominated grasslands are very small.

Blue grama communities are heavily overgrazed as shown by the high ground cover of this species that increases with grazing. This community may be a remnant of other grasslands in which it appeared historically as a subdominant.

The giant wild rye community occurs primarily on the floodplain of South Fork in close proximity to the riparian community, although it may also occur in isolated instances in smaller valleys and on alluvial fans.

Although not a true grassland, the weed community has the appearance of grassland. Severe disturbance has created this community now dominated by introduced annual and perennial grasses and forbs. One-third of the area encompassed by the weed community was at one time used for cultivated crops or as improved pasture. The remaining acreage in the weed community has been disturbed by intense grazing and trampling and erosion. It is important to note that the weed community is that it may serve as a seed source for weedy species which might invade reclaimed mining areas.

d. Steppe

The grass/half-shrub/forb community is confined to localized topoedaphic[1] conditions, on the upland breaks and toe-slopes of hillsides. This community has the most diverse species composition of all communities and covers approximately 20 percent of the Spring Creek area. Within this community, bluebunch wheatgrass and needle-and-thread are the most abundant grass species.

2. RARE AND ENDANGERED SPECIES

No known rare or endangered species are in the study area.

3. NOXIOUS WEEDS

Big Horn County and the State of Montana have designated 17 species in the county as noxious. Three species known to grow in the permit area, are Canada thistle, field morning-glory (or field bindweed), and wild licorice. Perennial sow thistle has been observed upstream from the permit area.

G. WILDLIFE

During 16 months of wildlife study, beginning in January 1976, four classes of vertebrate animals (mammals, birds, amphibians and reptiles), consisting of 163 species, have been identified as utilizing a

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[1]Topoedaphic is the combination of topographic and soil characteristics that help influence plant distribution and/or plant growth in a given area.

study area of about 100 square miles, including the permit application area on either a year-round, seasonal, or migratory basis. Literature indicates that an additional 20 species, although not observed during the study, have ranges which overlap the study area. Species list are in appendix G-1.

The vegetative types delineated in the vegetation section delineate generalized wildlife habitat types. Six general habitat types, each determined by physiognomically similar vegetation communities, or aspects of similar communities, have been identified in the Spring Creek area. Table II-10 shows the wildlife habitat types and the estimated total acreage of each type.

TABLE II-10.--Wildlife habitat in the Spring Creek permit area

Habitat type	Estimated acreage
Ponderosa pine/juniper	[1] 146
Sagebrush/grass	2,323
Grass	1,838
Silver sagebrush/riparian	153
Upland Shrub	104
Total	4,418

[1] Estimated acreages for the ponderosa pine/juniper community are not included in the total acreage.

1. LARGE MAMMALS

a. Antelope

The study area is an important winter habitat for antelope: groups of 100 or more animals have been seen during winter months. The size of the antelope herds generally decreased from winter 1976 through spring 1977, as animals dispersed from the area of study. The number of animals then increased again as the does and kids began to congregate and were joined by bachelor herds. By January 1977, the permit area had a herd of 290 antelope.

Areas of major use by antelope are the flat, open habitats of sagebrush/grass and grassland that predominate in the northern half of the study area (fig. II-12). The fact that two-thirds of the total winter sightings in 1976 and 1977 occurred in these types of habitat demonstrates the importance of sagebrush/grass habitat.

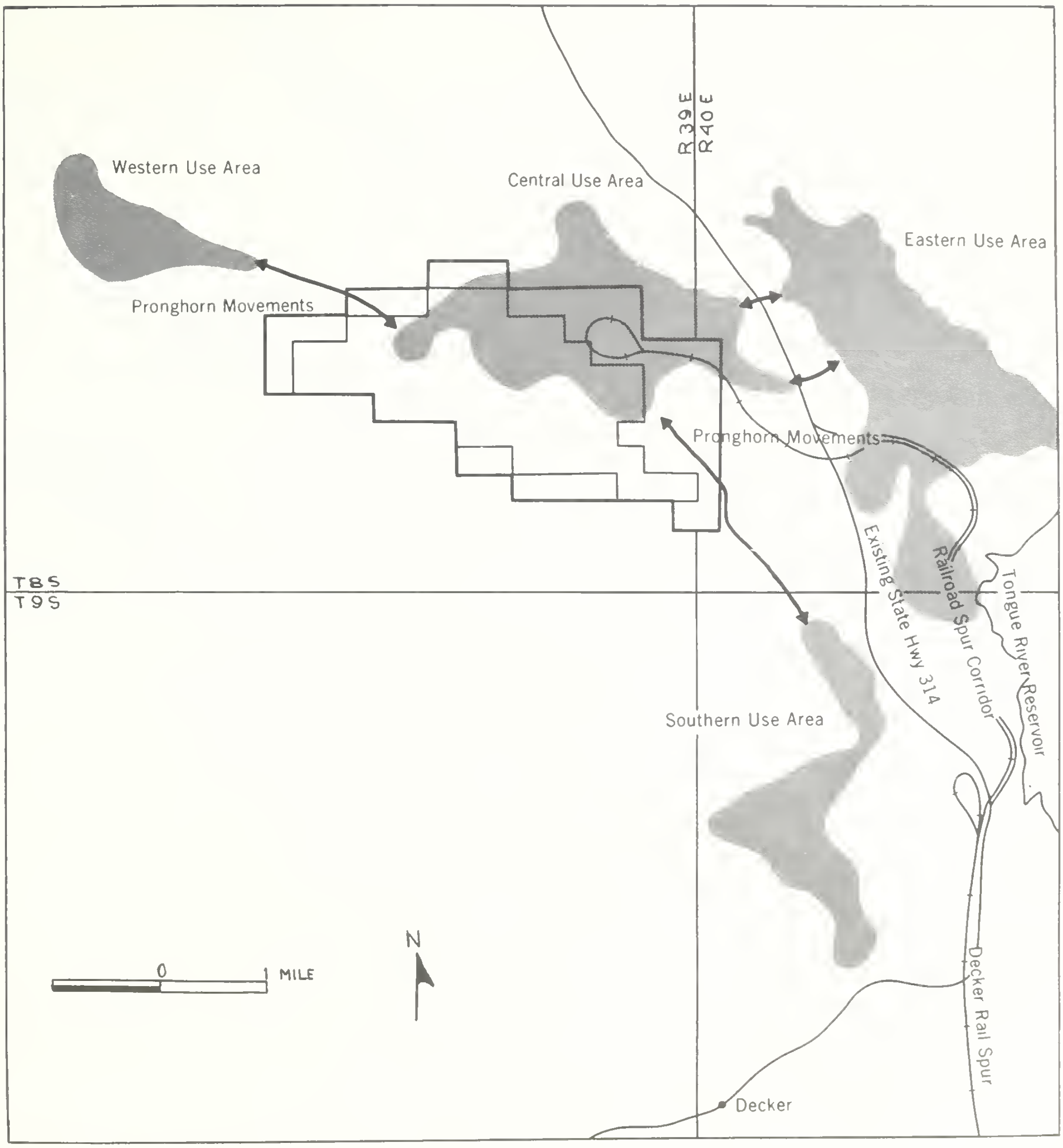

FIGURE II-12.--Major antelope use areas.

b. Mule deer

Herds of mule deer migrate within and through the Spring Creek study area, as indicated by seasonal fluctuations in animal populations (Biggins, 1976). Large herds of mule deer use the study area as a wintering area, and then may disperse 25-30 miles to the north and west during other seasons[1] (fig. II-13). The study site also serves as a year-round residence for smaller herds of mule deer. Mule deer numbers on the study area reached a low point in the late spring-early summer of 1976 and then generally increased through the winter. This indicates that the proposed mine and surrounding area comprises habitat critical[2] to the local and migratory mule deer herd, especially in times of severe winter stress.

Most mule deer observed during the study period were seen on the southern and western portions of the study area and on ponderosa pine/juniper covered ridges in the northern portion (fig. II-13). Mule deer occupy ponderosa pine/juniper habitats during the winter and summer months; however during the winter-spring and summer-fall transition periods they use the sagebrush/grass habitat most frequently.

c. White-tailed deer

Observations indicate that very little of the study area is used by white-tailed deer. Most sightings have been made on the southern extremity of the Tongue River Reservoir and to the south of the permit area.

2. OTHER MAMMALS

Other mammals in the area include bobcat and coyote, rabbits, and small rodents. Bobcats were observed on the study area only twice by VTN personnel. At least four coyote families resided on the study area, family sizes varied with two, three and four pups. Populations of coyotes and bobcats have undoubtedly been reduced by hunting and trapping.

The white-tailed jack rabbit has been sighted, but is not abundant, and, evidently, has no special affinity for a particular habitat type. Conversely, the desert cottontail is very abundant in the Spring Creek area and mainly utilizes the ponderosa pine/juniper and sagebrush/grass habitats.

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1 A high estimate of 388 mule deer was made during a single aerial flight in April 1977 (VTN, Inc., wildlife study in the area of the proposed Spring Creek mine).

2 Use of the word "critical" is meant to convey biological importance and is not to be confused with the legal implication contained in Sec. 50-1042 of the Montana Strip and Underground Mine Reclamation Act.

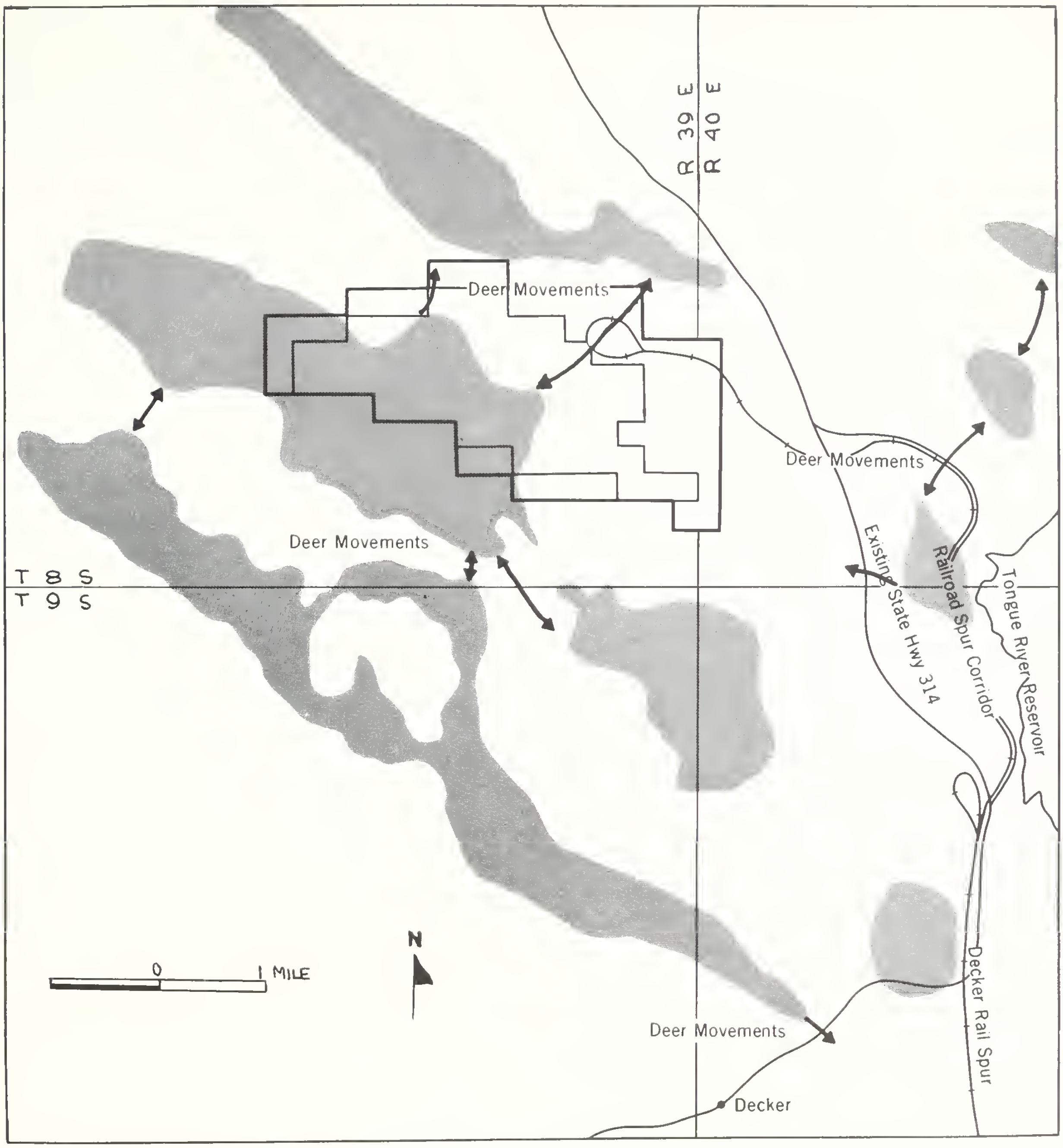


FIGURE II-13.--Major mule deer use areas.

Twelve species of rodents were sighted during VTN studies. Trapping of rodents revealed that the deer mouse population greatly exceeded all other small rodent populations. The most important habitat for small rodent populations was ponderosa pine/juniper, followed by areas containing sagebrush, while grass habitats appear to be least important.

3. UPLAND GAME BIRDS

Sage grouse, the most commonly observed upland game bird, have three active breeding-display sites within the 100-mile study area (fig. II-14). The largest concentrations of sage grouse seen during display seasons of both 1976 and 1977 (28 and 35 birds, respectively) were at "Upper Divide" lek; smaller concentrations were observed at the "Wind-mill" lek.

The most important winter habitat for sage grouse within several miles of the mine area is probably near the western boundary of the permit area (fig. II-14). This area probably provides winter habitat for birds from both the "Upper Divide" and "Windmill" breeding-display areas. During fall and winter of 1976-77, groups of more than 100 birds frequented this area, with over 1000 observations recorded in February 1977, alone. The sage grouse prefer sagebrush/grass habitat generally during the year, but move to sagebrush of more dense cover in winter because of its better provision for cover and food.

The second most abundant game birds, sharp-tailed grouse, used five leks in or near the permit area. "Charlines" lek is the most heavily used of the display areas (fig. II-14). Winter habitat is dominantly sagebrush/grass. During the rest of the year primarily grass habitats are used, while the sagebrush/grass habitats are subordinate.

Gray partridge observations were scattered over the entire study area, primarily in the sagebrush/grass habitat and secondarily in the grass habitat. Large winter concentrations were noted in both habitats in January 1977.

Observations indiate that ring-necked pheasant are concentrated in the south and east edges of the study area, near the year-round water supply of the Tongue River.

4. RAPTORS

Nineteen species of raptorial birds were observed during the 16-month study. The golden eagle was the only species observed in all 16 months although some red-tailed hawks, marsh hawks, prairie falcons, American kestrels, and great horned owls are known to reside in the area. Of the nine raptor species commonly observed during the spring and summer season, six are known to have nested in the permit area; the American kestrel being the most common (fig. II-15). The golden eagle nest, within the permit area and north of the railroad loop, was destroyed by high winds during the spring of 1977. The pair of eagles

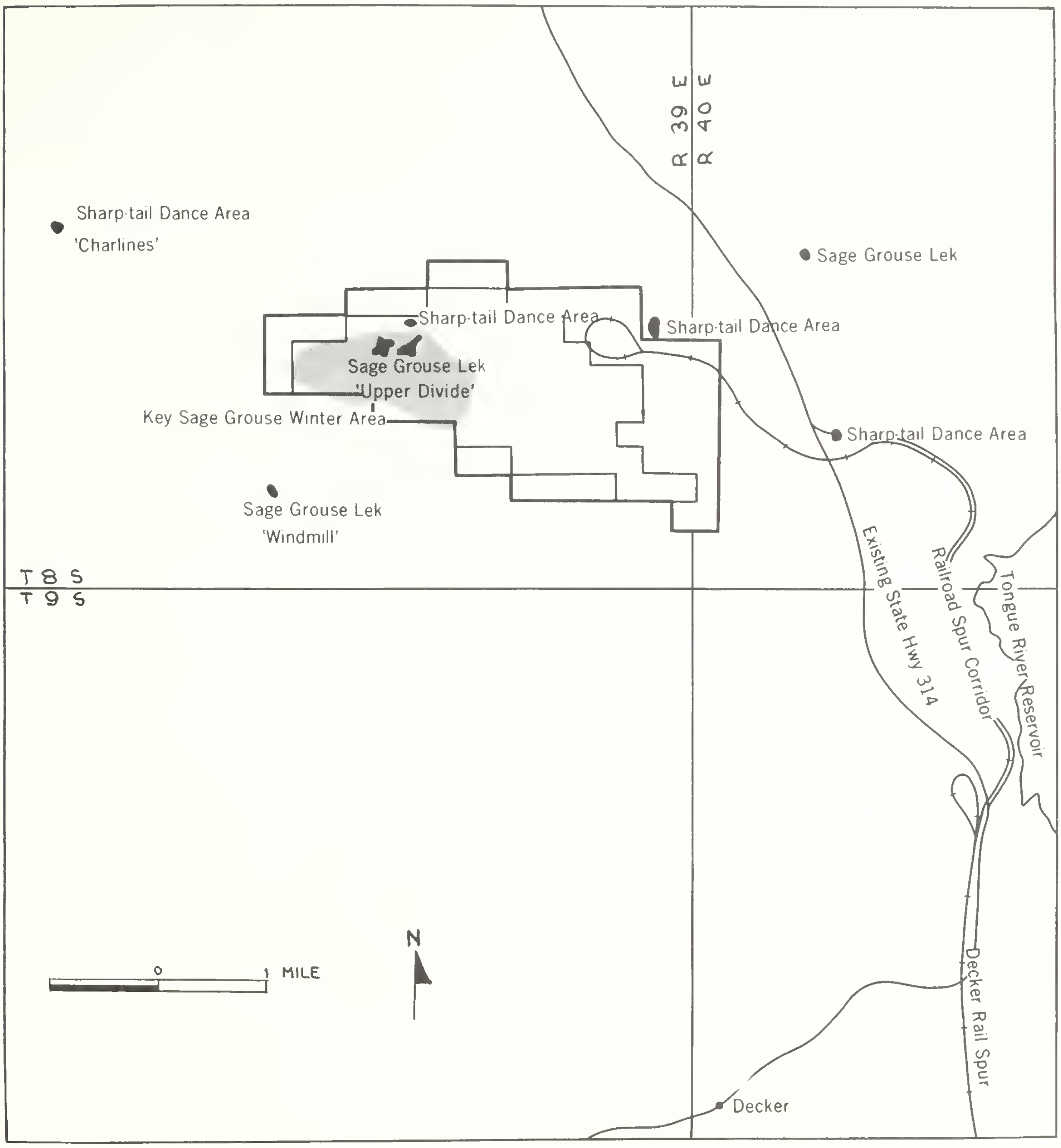


FIGURE II-14.--Grouse wintering and breeding areas.

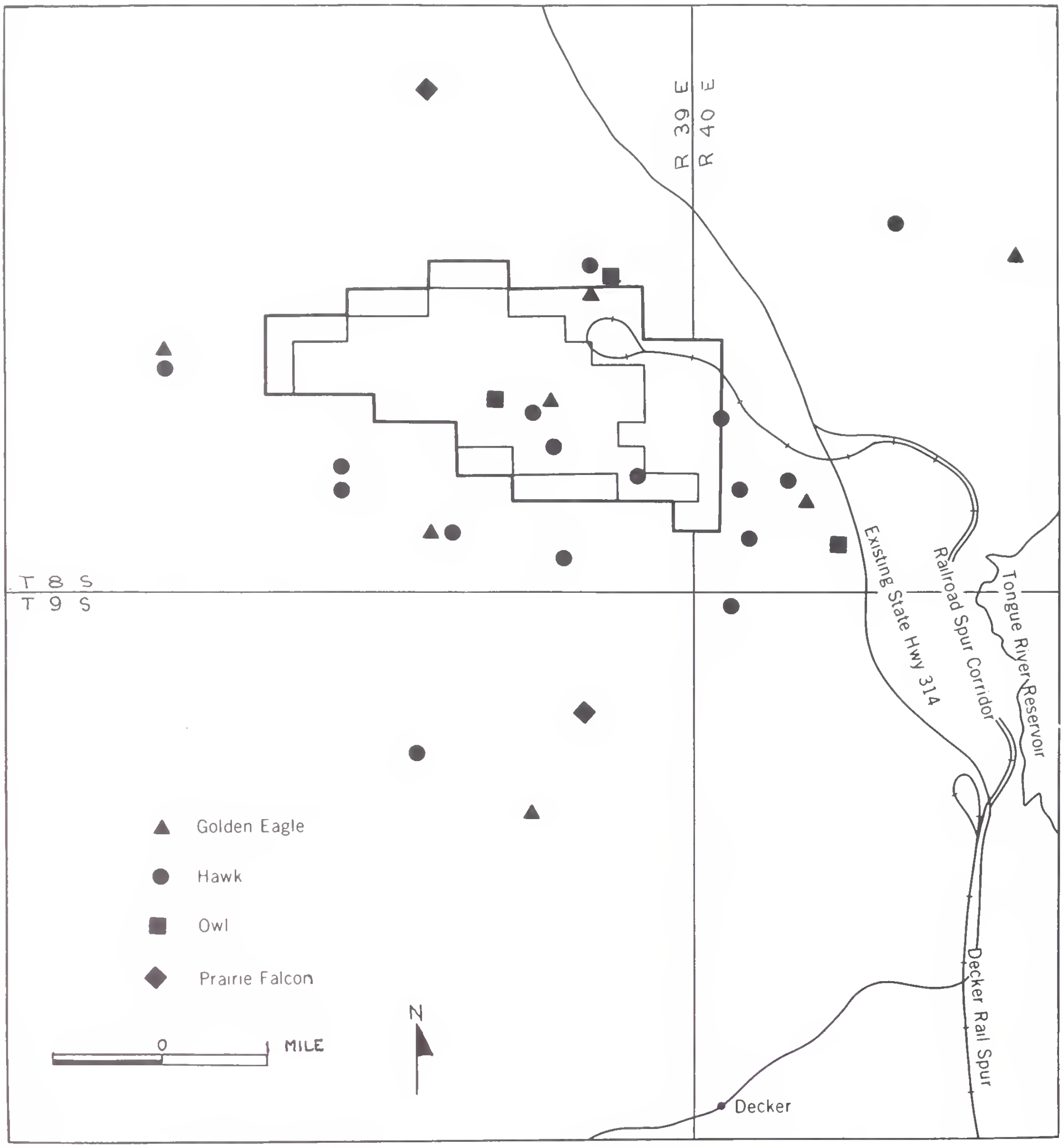


FIGURE II-15.--Raptor nest locations.

which used this nest established a new nesting site, outside the permit area, in the spring of 1978. The other eagle's nest, shown within the permit area, was determined to be a red-tailed hawk's nest by members of the U.S. Fish & Wildlife Service (appendix G-2).

Habitats most commonly used by raptors are sagebrush/grass and ponderosa pine/juniper. Of the total yearly observations, 30 per cent occurred in sagebrush /grass habitat, and 27 percent in the ponderosa pine/juniper habitat. These habitats are also important to rodents, a primary food of the raptors. Conifers and deciduous trees and snags, and sandstone cliffs are of particular importance to all raptors for nesting and perching (Lockhart, J. M., 1976, oral comm.).

5. SONGBIRDS

The permit area has 62 known species of songbirds (appendix F1), 39 of them summer residents, 14 migrants, four winter residents, two year-round residents. Three species are undetermined but probably they are summer residents (the permit area is within their breeding range). The most abundant species is the meadowlark, a summer resident. The ponderosa pine/juniper habitat supported the most diverse bird populations, the silver sagebrush/riparian habitat the next, and the grass habitat the least.

6. AMPHIBIANS AND REPTILES

Thirteen species of amphibians and reptiles have been identified in the permit area, and another five species may be present. (appendix F-1).

The boreal chorus frog and the leopard frog, the most common amphibian species in the area, are restricted to the silver sagebrush/riparian habitat.

Of the six snake species identified in the permit area, the prairie rattlesnake was sighted most frequently. The prairie rattlesnake also had the widest distribution of the snake species, occurring in all five habitats. The bullsnake is the second most frequently sighted snake species and has been observed mainly in grass and sagebrush/grass habitats.

7. ENDANGERED SPECIES

The endangered Peregrine falcon was observed once during the VTN studies in the extreme southeast portion of the study area--in a tree in riparian habitat along the Tongue River. Peregrine falcons are not known to nest within the study area. The only other species sited with the study area was the bald eagle which uses the area around the Tongue River Reservoir during the winter months.

8. FISHERIES

Fish are not present within the permit area because of the ephermeral nature of Spring Creek and South Fork Spring Creek.

H. SOCIOLOGY

The Birney-Sheridan area comprises portions of Big Horn County, Montana and Sheridan County, Wyoming (fig. 1- 2). The portion of Big Horn County in which the proposed Spring Creek mine would be located is known as the panhandle because it is separated from other non-Reservation parts of the county by the Crow Indian Reservation and the western half of the Northern Cheyenne Reservation, which are within Big Horn County. This part of the county is characterized by clustered ranch units that form natural rural communities and small villages. Such communities usually consist of a post office, a church or school, and a store or bar. It is anticipated that about 10 percent of the employees at the Spring Creek mine would live in Big Horn County.

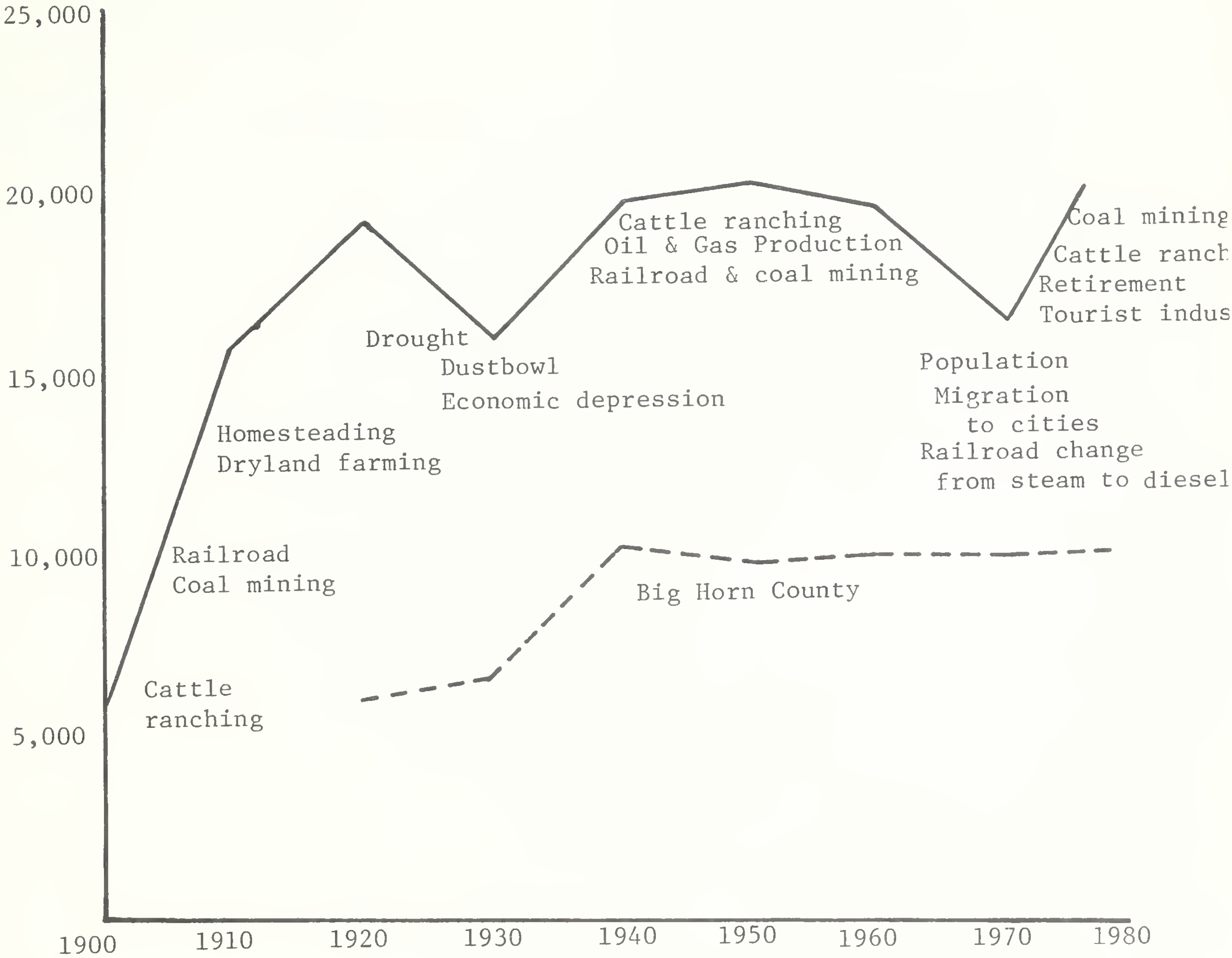
The area of Sheridan County that would be most affected by population increases due to the presence of the Spring Creek mine would be the urbanized arc that begins at Dayton and extends eastward and southward through Ranchester to Sheridan, Wyoming. This region contains approximately 60 percent of the population of Sheridan County. It is anticipated that about 90 percent of the employees at the Spring Creek mine would live in Sheridan County. Of this 90 percent, most would be expected to live in the town of Sheridan.

1. POPULATION

Historically, the Birney-Sheridan area has experienced a number of boom and bust population cycles (fig. II-16; table II-11). The early cycles were related primarily to the cattle boom, the homesteading boom, and the oil and gas boom. The present era of strip mining for this portion of Big Horn County began in 1972 with the opening of the West Decker Mine.

Between 1970 and 1976, Big Horn and Sheridan Counties grew by 5.6 percent and 17.0 percent, respectively (table II-11). These growth figures correspond to increasing coal-related activities in both counties. Mine development has caused a rapid population growth since 1970 for the towns of Sheridan (21.6%), Ranchester (+ 101.9%), and Dayton (+ 38.9%). Because of the proximity and access of this urbanized center to the mining area, the mine related population growth has occurred in the Sheridan urban area instead of the rural portions of Big Horn County.

The influx of newcomers appears to have been rapid enough (greater than 500/year since 1972) that they have not been able to assimilate smoothly into the local community. This has produced social changes and signs of social disorganization. The rural areas adjacent to the mining properites have also seen significant changes due to mining activities.



Sheridan County was created in 1885; Big Horn County in 1913.

FIGURE II-16.--Population cycles in Sheridan and Big Horn Counties.

TABLE II-11.--Population change in Big Horn County and Sheridan County area

[Source: U.S. Census, Big Horn County Special Census 1976, and Sheridan Area Planning Agency population study 1976]

Year	Big Horn County	Sheridan County	Region
1900	([1])	5,122	([1])
1910	([1])	16,324	([1])
Percent change	([1])	+218.7	([1])
1920	7,015	18,182	25,197
Percent change	([1])	+11.4	([1])
1930	8,543	16,875	25,148
Percent change	+21.8	-7.2	+0.88
1940	10,419	19,255	29,674
Percent change	+21.9	+14.1	+16.7
1950	9,824	20,185	30,009
Percent change	-5.7	+4.8	+1.1
1960	10,007	18,989	28,996
Percent change	+1.8	-5.9	-3.4
1970	10,057	17,852	27,909
Percent change	+0.5	-6.0	-3.7
1976	10,618	20,800	31,418
Percent change	+5.6	+17.0	+12.6
Percent change (1940-1970)	-3.5	-7.3	-5.9
Percent change (1940-1976)	+1.9	-8.0	+5.9

[1]Not available, as Big Horn County was created out of parts of Rosebud and Yellowstone Counties in 1913.

The populations of both Big Horn and Sheridan Counties are expected to show general increases even without the addition of the Spring Creek mine (table II-12). Regional migration trends, of which Big Horn and Sheridan are a part, indicate that population net-inmigration will continue at least through 1990.

General population increases in Big Horn and Sheridan Counties are a direct reversal of population trends that existed from 30 years prior to 1970. Between 1940 to 1970 both counties lost people. The net-outmigration for Big Horn County was 3.5% (10,419 to 10,057 people). Sheridan County lost about 7.3% of its population (19,255 to 17,852 people).

The population net-outmigration in this area can be attributed to several factors. Agriculture during the period from 1940 to 1970 underwent a pronounced "mechanization period" in which labor was basically replaced, or substituted by fossil-fuel-operated machinery. Fewer people were needed to operate ranches and farms. Secondly, the deep-shaft coal mines in Sheridan County closed as a result of coal being replaced as a fuel by diesel, natural gas, and gasoline. Additionaly, as the viability of many marginal and smaller ranches declined, neighbors would buy them to increase their own economic viability. Those who sold out generally bought better ranchers in the area, or left the area altogether.

With the advent of large scale strip mining and other fossil fuel related activities in Big Horn and Sheridan Counties in the early 1970's, population trends began to show a net increase. From 1970 to 1976, population grew from 17,852 to 20,800 people in Sheridan County. In Big Horn the increase in population was not as significant as Sheridan's, but the population did grow from 10,057, in 1970, to 10,618 people by 1976.

Population projections for Big Horn and Sheridan Counties indicate a general increase from 1978 to 1990. If the Spring Creek mine is approved, the growth rate would increase; however, following the initial period of construction, in about 1981, there would probably be a short-term out-migration from both counties, as construction workers leave the area.

The population characteristics of Big Horn and Sheridan counties significantly differ in racial composition (table II-13). Big Horn County has a large Indian population relative to Sheridan County. In 1970, 39 percent of Big Horn's total population was comprised of Indians living mostly on the Crow Reservation. In contrast, Sheridan County had a very small Indian population. Only 0.4% of Sheridan's total population was represented by American Indians. Although the baseline information used for this comparative racial analysis was established through the 1970 census, the general racial attributes of the population have not substantially changed in recent years.

TABLE II-12.--Projected population changes in Big Horn and Sheridan Counties and the towns of Hardin, Montana and Sheridan, Wyoming, without the Spring Creek mine,* 1978 to 1990

	Population (Counties)		Population (Cities)		Net Migration** (Counties)	
	Big Horn	Sheridan	Hardin, MT	Sheridan, WY	Big Horn	Sheridan
1978	10,609	23,081	2,858	16,328	134	430
1979	10,600	22,758	2,849	16,005	-71	-457
1980	10,694	23,011	2,943	16,258	33	121
1981	10,985	23,288	3,234	16,535	228	144
1982	11,160	23,568	3,409	16,815	111	145
1983	11,341	23,855	3,590	17,102	116	150
1984	11,533	24,152	3,782	17,399	127	159
1985	11,733	24,455	3,982	17,702	133	163
1986	11,975	24,834	4,224	18,081	174	237
1987	12,222	25,224	4,471	18,471	177	246
1988	12,474	25,613	4,723	18,860	181	243
1989	12,729	25,995	4,978	19,242	183	233
1990	13,491	27,391	5,740	20,638	688	245

* This assumes that additional new activity is derived from existing mine expansion in the two-county area without new mining.

** Net migration is calculated from the number of people moving into the respective county less those moving out of the county.

TABLE II-13.--1970 Population characteristics for Sheridan County, Wyoming and Big Horn County, Montana compared with State and national averages

[Source: U.S. Department of Commerce, 1970]

Characteristics	Sheridan County	State of Wyoming	Big Horn County	State of Montana	United States
Net migration (1960-1970)--------	-8.3	-11.9	-17.9	-8.6	1.7
Birth rates/ 1000 (1969)-------	14.5	17.4	21.5	17.3	17.5
Death rates/ 1000 (1969)-------	13.7	8.9	10.0	9.7	9.5
Racial characteristics					
White-------------	99.0	97.5	60.0	95.7	87.5
Negro-------------	0.2	0.7	--	0.3	11.1
Indian------------	0.4	1.5	39.0	3.8	0.4
Other-------------	0.4	0.3	1.0	0.2	1.0
Household size------	2.8	3.1	3.7	3.1	3.2
Education attainment (Persons 25 yrs. old or older)					
Median yrs. of school completed----------	12.3	12.4	11.2	12.3	12.1
Less than 5 yrs.	2.5	2.6	3.5	1.0	5.5
Four yrs. of high school or more----------------	60.4	62.9	44.4	17.9	52.3
Four yrs. of college or more----------------	11.2	11.8	9.4	3.6	10.7

2. SOCIAL ORGANIZATION[1] AND ONGOING SOCIAL IMPACTS

The social environment into which the proposed Spring Creek mine would be permitted is presently going through a period of rapid growth and social change. Although this growth and change could not be considered as "boomtown" (Gilmore, 1976), it is still in an unstable condition.

The society[2] that developed in the Birney-Sheridan area is the result of a process of social interactions and relationships that helped people to survive and develop a meaningful way of life. Cattle ranching and dryland farming were and still are the primary forms of agriculture. Many of the ranch and farm families of today are third and fourth generation. As a result of this agricultural base and varying environmental conditions, the pattern of land settlement was such that towns were small and neighbors far apart. Roads and highways have developed, along with settlement patterns, in a way that has influenced social relationships.

The intervention of the new mining era has produced signs of strain and disorganization on this existing social organization. Both the rural and urban areas have seen significant social changes since the recent mining era began. Large numbers of newcomers have brought foreign styles of life, value systems, and different ways of earning their livings. Many long-term residents find these new lifestyles and population increases disturbingly different from their traditional way of life. The influx of newcomers has been rapid enough that they have not been able to be smoothly intergrated into local communities.

a. Big Horn County

Big Horn County is socially organized into natural rurual communities which have been described by Gold (1975). These communities represent the basic social and cultural arrangements of people in and around the mining area (see map figure II-17). Existing mining activities are principally affecting the communities of Birney, Decker, Fourmile, and Kirby. The communities of Ashland and Quietus-Sayle are being affected by the present mining more indirectly. The size of ranches, continuity of families, status of strip mining, and community members' attitudes toward mining are important variable influencing the effects of strip mining on these natural rural communities.

There appears to be a correlation between ranch size and dependence on grazing permits. Ranches which are small in land area may have herds as large or larger than ranchers who own more land. Such

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[1] Social organization refers to the relatively stable pattern of social relationships of individuals and subgroups within society.

[2] A "Society" refers to a group of people who interact more with each other than they do with other individuals -- who cooperate with each other for the attainment of certain ends (Kluckhohn, 1974).

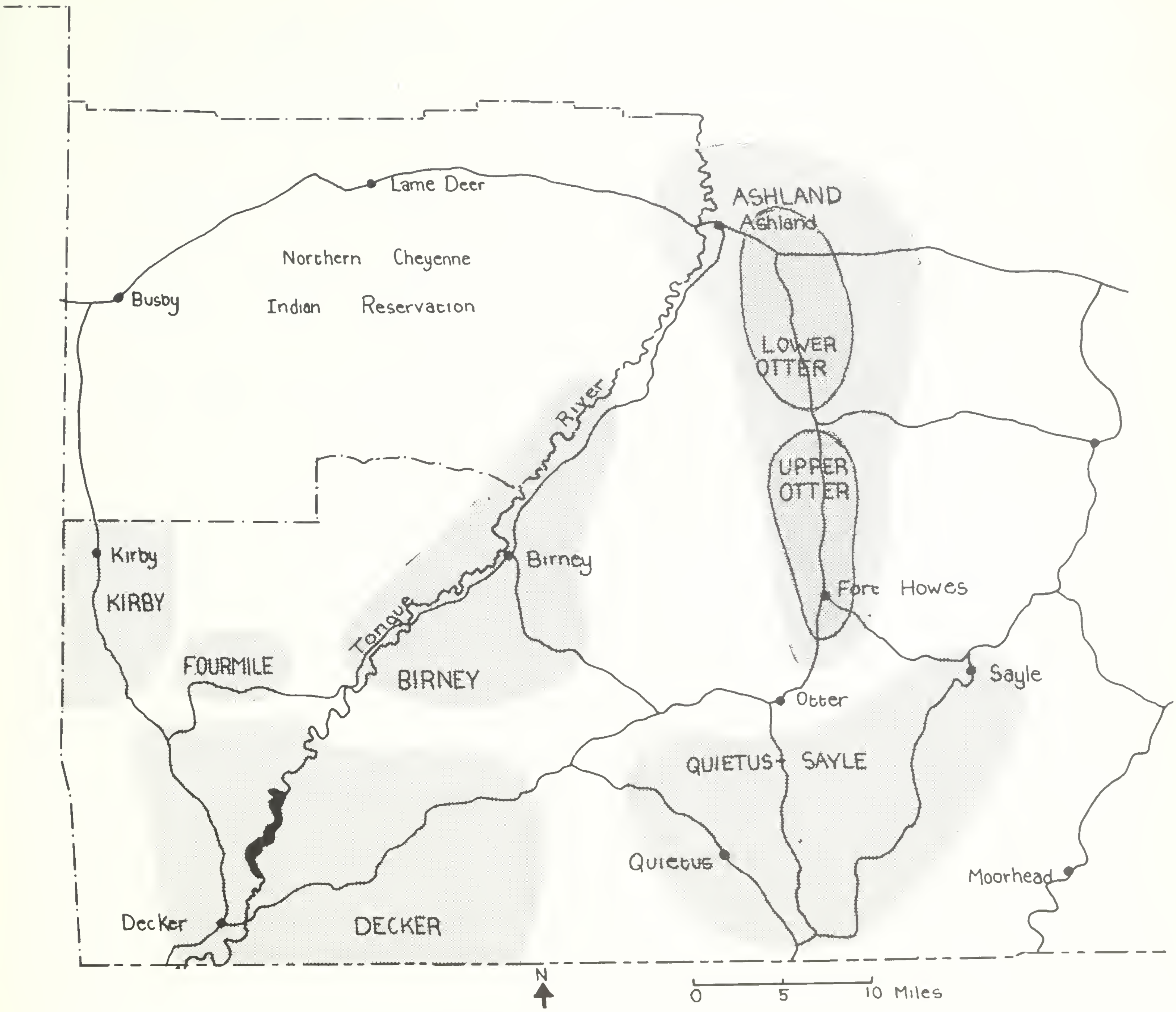

FIGURE II-17.--Natural rural communities, Big Horn County. (Modified from Gold, 1975.)

operations are greatly dependent on grazing permits. Those with small deeded ranches tend to feel they are in an unstable situation around strip mining operations because the stripping, roads, railroads, and utility corridors could easily cut them off from the private or permit land they rely on. Larger ranches also feel threatened, but some say they could live with mining if the coal is exported.

The continuity of families is an important part of members' attitudes and actions about strip mining. Third or fourth generation families are generally proud that they have been on the land that long. Through such families, the remnants of the earlier lifestyles of the cattle and homesteading eras are somewhat maintained. The memory of this kind of lifestyle is important.

There are actually two communities in the Decker area. One is bound tightly together by traditional family continuity; the other comprises first and second generation families who are more loosely bound to each other and the land.

Attitudes toward coal development are determined by people's perception of the effect coal mining will have on his or her community. According to Gold, people in 1975 were overwhelmingly opposed to strip mining. However, he noted that it was becoming more accepted. Those who support coal mining feel they can learn to live with it. They indicate that they've had it before and they can learn to live with it again.

At first, there seemed to be a resentment against those who sold or leased early; however, more people seem to be accepting the idea that mining is inevitable. They may have the attitude that "I may as well lease because my neighbor has and if they mine on his land they might as well mine here also" (Gold, 1975).

Those in the Decker area seem to be the only ones who feel they have been abandoned to industrialization, according to Gold. Many around the Decker area feel that ranching is too marginal and that mining should therefore occur, especially if it gives the rancher enough money to buy a better ranch elsewhere. Many have sold and bought other ranches in the same area.

Those around Birney who support coal mining feel that it is provincial to oppose the opportunities and responsibilities the new situation would bring. Opponents of mining contend that supporters have closed their eyes to social problems and have broken the traditional isolation of the Birney community. They also claim that supporters are unduly money-oriented and accept the reclamation claims of the coal companies without proof.

b. Sheridan County, Wyoming

Less is known about the social organization of Sheridan County, making it difficult to describe it with a level of detail similar to the description of the mining area in Big Horn County. Although mining is currently going on in Sheridan County, the impacts of population growth by Montana mines on the urban areas of Sheridan is of primary concern. It is anticipated that more information on Sheridan County will be incorporated into the final environmental statement.

Before the mine at Decker opened, the town of Sheridan was considered to be an attractive retirement community. This was illustrated by the presence of a large percentage of people over the age of sixty. The community also served as a regional trade center for the rural areas of north-central Wyoming and extreme southeastern Montana. As mining and related activities increased in Montana, the corresponding increases in people were drawn to the Sheridan urban area. This was primarily the result of available housing, existing social and community services, the shopping district, professional services, and the lack of established towns close to the mines.

Gold (1975) pointed out that the town of Sheridan has, to this point, benefited economically from growth, which has not been rapid or large enough to be very adverse. He pointed out that although people of Sheridan have shown very little desire for the town to change from its current position as a regional shopping center, some people are hoping to benefit from new jobs and new money. From the time of Gold's study to the present, there has been a steadily increasing population of people seeking primary or secondary jobs created as a result of mining in the region.

Since 1975, impacts of increased growth have become noticeable in the form of crowded schools; increased housing costs and shortages; rising crime rates, welfare payments, and mental health problems; and strains in the delivery of community and health services (see Community Services).

I. ECONOMICS

1. INTRODUCTION

Traditionally, both counties were primarily agriculturally based with ranches forming small natural communities throughout the area. Ranches have historically been in families for generations. The city of Sheridan has been the regional marketing center, along with being a retirement community. As a result of little or no economic growth for the past fifty years, prior to the 1970's, Sheridan's patterns were well developed.

Coal mining slowed to nearly nothing in the 1950's; however, its recent resurgence in the 1970's is impacting both Sheridan and Big Horn Counties. Mine developments have occurred primarily in Big Horn County; however, the associated population from the Montana mines has settled predominantly in the Sheridan urban area.

2. EMPLOYMENT

People in the twocounty area have been dependent upon employment from the cities of Sheridan and Hardin[1] and from the agricultural base of the area. The majority of agricultural employment is derived from family owned ranches who lease sizeable tracts of federal land for grazing purposes.

Table II-14 depicts total employment (1975) in Big Horn and Sheridan Counties by sector, and shows comparative percentage contributions of the barious sectors to total employment in both counties, in the state of Montana and Wyoming, and the United States. From this analysis, it is apparent that both farm proprietor's employment and farm salaried employment represent a larger portion of total employment than do those for the State of Montana, the State of Wyoming, and the United States. Government employment in the two-county area is also larger, and privated non-farm sector employment is smaller than for both states and the country. Due to non-disclosure, the mining sector for the two counties cannot be determined using offical government data.

Although the sectoral data in table II-14 are incomplete, construction and mining employment have increased since 1975. Currently, Decker Coal Company employs 335 people at its East and West Decker mines operations (Big Horn County). During 1976-1977, with the construction of the East Decker mine, between 400 and 600 construction workers were

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1/ Hardin, the county seat of Big Horn County, Montana is peripheral to the Regional area, but it is the major center of population and employment for the county.

TABLE II-14.--Employment by sector for 1975 in Big Horn County and Sheridan County

[Source: Bureau of Economic Analysis, U.S. Department of Commerce]

Sector	Big Horn	Sheridan	Two County total	Percent of two total	Percent of Montana total	Percent of Wyoming total	Percent of United States total
Total Employment	4,035	8,843	12,878	100.0	100.0	100.0	100.0
Farm proprietors	546	485	1,031	8.0	8.2	4.6	3.2
Non-farm proprietors	388	1,048	1,436	11.2	10.1	8.7	7.3
Farm	474	358	843	6.4	4.0	3.2	1.2
Government	1,006	2,038	3,044	23.6	20.5	21.3	16.8
Private non-farm	1,621	4,914	6,535	50.8	57.0	62.1	71.5
Manufacturing	([1])	318	---	---	7.6	4.6	21.3
Mining	269	([1])	---	---	2.3	9.9	.7
Construction	177	700	877	6.8	4.3	7.9	4.2
TCU[2]	113	364	477	3.7	6.0	7.0	5.0
Trade	31	1,803	1,834	14.2	18.2	17.1	18.2
FIRE[3]	82	251	333	2.6	3.0	2.5	4.5
Services	391	1,279	1,670	13.0	15.2	12.7	16.8
Other	([1])	([1])	---	---	.3	.3	.3

[1] Deleted to prevent disclosure of confidential data
[2] Transportation, communication, and public utilities
[3] Finance, insurance, and real estate

templorarily employed. New mining activities have generated additional construction and wholesale/retail employment in and around the city of Sheridan. This impact of workers felt in Sheridan and at the Tongue River Reservoir, where many of them live in temporary quarters. Peter Kiewit Sons' Company employs 175 workers at its Big Horn Mine. All of this mining employment is new to the area since the early 1970's. The Decker operators are members of the Progressive Mine Workers Union, while Big Horn employees belong to the United Mine Workers. Attempts have been made to have the Big Horn workers join the Progressive Mine Workers Union.

Table II-15 portrays unemployment rates for Sheridan and Big Horn Counties for the year 1970 thru the first quarter of 1977. Comparative figures for Wyoming and Montana, and the United States are also shown. Unemployment is higher in Big Horn County then in Sheridan County because of the large indian population on the Crow and Northern Cheyenne Reservations. It is likely that many of the Indians in the area, faced with discrimination, poor education, and an absence of marketable skills in a non-Indian economy have stopped looking for work, assuming that none is available to them. Historically, unemployment rates have been higher in Sheridan County than in other counties of Wyoming, because of the unavailability of jobs in Sheridan County through the last several decades.

TABLE II-15.--Unemployment rates in percentages

Sheridan County, Wyoming and Big Horn County, Montana;
States of Wyoming and Montana; and United States

	1970	1971	1972	1973	1974	1975	1976	1st Qtr. 1977*
Sheridan County	4.2	4.1	4.6	4.0	4.1	5.4	4.1	5.3
Wyoming	4.4	4.4	4.0	3.4	**	4.4	4.1	4.7
Big Horn County	4.6	**	**	**	**	**	**	11.1
Montana	5.6	6.2	6.1	6.2	6.7	8.1	7.8	9.0
United States	4.9	5.9	5.6	4.9	5.6	8.5	7.7	8.2

* Not Seasonally Adjusted
** Not Available

Source: U.S. Department of Labor, Bureau of Labor Statistics: Wyoming Employment Security Commission; Montana Employment Security Division 1977.

3. INCOME

With the new mining activity, increased income is being realized by some people. New payrolls have generated new forms of employment in the Sheridan area in terms of construction, wholesale/retail-and service-related payrolls.

Based on data obtained from the Bureau of Economic Analysis, total wage and salary disbursements for the two counties increased by 32 percent for the years 1970-1975. Table II-16 depicts total wages and salaries for the two county area. Over the five year period, earnings in Sheridan County increased at a more rapid rate than in Big Horn County.

TABLE II-16.--Total Personal Income, 1970-1975, for Big Horn and Sheridan Counties

(thousands of dollars)

Source: Bureau of Economic Analysis, U.S. Dept. of Commerce, R.E.I.S. Program.

County	1970	1971	1972	1973	1974	1975
Big Horn	$40,853	$34,651	$45,516	$56,459	$53,758	$51,268
Sheridan	61,837	59,887	63,186	76,179	79,484	83,997
Total	$102,690	$94,538	$108,702	$132,638	$133,242	$135,265

Table II-17 shows per capita income between 1970 and 1975 for the two respective counties as well as comparative figures for the states of Montana and Wyoming. Per capita income in Sheridan County was higher than that for the State of Wyoming ($6,204 in 1975) while Big Horn County was below the Montana annual average ($4,482 in 1975). In addition, 1975 data reveal that per capita income for the State of Wyoming exceeds that for the State of Montana. The lower income of Indians in Big Horn County influences this lower per capital income. Table II-17 also indicates that income in Sheridan County, Wyoming grew by a greater percentage than that in Big Horn County, Montana.

TABLE II-17.--Per Capital Income 1970-1975, Sheridan County, Wyoming and Big Horn County, Montana; and States of Montana and Wyoming

	1970	1971	1972	1973	1974	1975	%Change 1970-1975
Big Horn	$3,132	$2,948	$3,541	$4,302	$4,456	$4,482	43.1
Sheridan	4,236	4,447	4,675	5,270	5,885	6,204	46.4
Montana	3,500	3,576	4,070	4,784	5,079	5,433	55.2
Wyoming	3,815	3,868	4,278	4,948	5,644	6,079	59.3

Source: Bureau of Economic Analysis, U.S. Dept of Commerce, R.E.I.S.

Table II-18 provides personal income by broad industrial sector for both counties for 1975. Also included are comparative percentage distributions of income by sector for the states of Montana and Wyoming, and the United States. Farm earnings (both farm proprietors' income and farm wage and salary earners) are more dominant in Big Horn County than in Sheridan County; although, in total, farm earnings (proprietors and wage and salary) represent nearly 15.3 percent of total income for the two-county area.

A unique characteristic of Sheridan County is that its service sector is quite large. Tourist and recreational activities, such as guest ranches, are seasonal and operate in the summer and fall, creating seasonal income that normally declines in the winter months. The services sector in Sheridan County, along with the wholesale/retail trade sector, represent nearly 30 percent of total earnings for the county. Other major sources of income in the two-county area are government income (21.2 percent) and wholesale/retail trade.

Economic analysis conducted in the area indicates that Big Horn County is a net exporter of agricultural and mining products. Nondisclosure law in Sheridan County does not allow such analysis; however, it is believed that Sheridan County is also a net exporter[1] of these products. Wholesale/retail trade and the construction sector in Sheridan County also reflect higher concentration than that of the U.S. The city of Sheridan is a regional trade center providing goods and services for northern Wyoming counties as well as for Big Horn and Rosebud Counties, Montana. Peter Kiewit Sons' regional offices are located in the city

1/ This analysis was conducted using location quotients. Net exportation represents shipping out more produce than is being imported into the county.

TABLE II-18.--Sector earnings for 1975 in Big Horn County and Sheridan County (thousands of dollars)

(thousands of dollars)

[Source: Bureau of Economic Analysis, U.S. Department of Commerce, R.E.I.S. Program]

Sector	Big Horn	Sheridan	Two County total	Percent of two County total	Percent of Montana total	Percent of Wyoming total	Percent of U.S. total
Total earnings-----------	$51,268	$83,997	$135,265	100.0	100.0	100.0	100.0
Other labor income-----	1,689	3,141	4,830	3.5	3.3	4.3	6.0
Proprietor's income----	11,015	10,264	21,279	15.7	18.0	9.9	8.0
Farm income--------	7,758	160	7,918	5.9	11.0	1.1	3.0
Non-farm-----------	3,257	10,104	13,361	9.8	7.0	8.8	5.0
Industry wage & salary---	38,564	70,592	109,156	80.7	78.7	85.8	86.0
Farm------------------	10,379	2,192	12,571	9.4	12.7	2.8	3.0
Government------------	9,646	19,146	28,792	21.2	17.0	17.7	16.0
Federal------------	5,657	9,198	14,855	10.9	6.5	7.1	6.0
State and local----	3,989	9,948	13,837	10.2	10.5	10.6	10.0
Private non-farm-------	18,539	49,254	67,793	50.1	49.0	65.3	67.0
Manufacturing------	([1])	3,345	---	---	7.5	5.5	22.0
Mining-------------	6,316	([1])	---	---	2.9	14.8	1.2
Construction-------	2,155	9,619	11,774	8.7	5.0	11.0	4.8
Trade--------------	4,216	13,654	17,870	13.2	13.5	12.4	14.4
FIRE[2]--------------	753	3,066	3,819	2.8	2.8	2.6	4.6
TCU[3]---------------	1,262	4,909	6,171	4.6	6.9	9.0	6.0
Services-----------	2,953	10,894	13,847	10.2	10.4	9.7	13.8
Other--------------	([1])	([1])	([1])	([1])	0.0	.3	.2

[1] Deleted to prevent disclosure of confidential data
[2] Finance, insurance, and real estate
[3] Transportation, communications, and public utilities

of Sheridan and provide sizable construction and mining employment in the two counties. The remaining sectors in Sheridan County are less concentrated than those in the United States. Coal extraction in Sheridan County is increasing with the operation of the Big Horn Mine and with new coal mining activity occurring at the Acme Mine. Together, the Decker and Big Horn mines promote substantial payrolls for the area.

Farm income is an important part of the two-county area. Sources of farm income are shown in Table II-19 for the year 1970 through 1975. Between livestock and crops, livestock is the more dominant source of income in both counties, although in later years crops have become more dominant in Big Horn County. In 1975, livestock sales were comparable for the two counties. The data in this table indicate the high degree of fluctuation in agricultural production and prices. Of the two counties, Big Horn has a greater agricultural income.

4. TAX STRUCTURE, REVENUES, AND EXPENDITURES

Montana and Wyoming are controlled by two entirely different tax systems. Because of the variegated nature of the two systems, an economic analysis covering the two states is complicated by the spillover effect of miners working in Montana and living in Sheridan County, Wyoming. The following tax analysis is an attempt to explain the tax system in order to help the reader understand the economic impacts on Big Horn and Sheridan Counties.

The following list portrays the general sources of tax revenue for the State of Montana:

General Tax Structure For Montana

a. Property taxes
b. Personal income tax
c. Corporation income tax
d. Highway users tax
e. Alcoholic beverage tax
f. Tobacco taxes
g. Insurance tax
h. Mineral resource taxes
i. Inheritance tax
j. Unemployment compensation tax

A special revenue policy for educational financing in Montana focuses on the general school budget, the foundation program permissive district levy, and other budget items. For purposes of financing highways, roads, and streets, the state relies on fuel taxes, property taxes, special improvement taxes, vehicle registration, gross vehicle weight tax, coal severance tax, and federal funds.[1] Currently, the property tax produces over fifty percent of State and local revenues, followed by

[1] For more detailed information concerning Big Horn County and Montana taxes see appendix I-1 including table A.

TABLE II-19.--Farm and ranch income 1970-75 (not adjusted for inflation)

[Data are in thousands of dollars. Source: U.S. Dept. of Commerce R.E.I.S.]

	1970	1971	1972	1973	1974	1975
Big Horn County, Montana						
Total Cash Received	25,852	23,595	32,861	37,336	37,221	33,023
Livestock	16,879	18,075	24,344	23,120	17,135	16,638
Crops	4,864	2,650	4,797	9,101	15,082	11,234
Other Income						
Govt. Payments	2,147	1,435	1,321	794	120	309
Imp. Inc. & Rent	1,962	1,435	2,399	4,321	4,884	4,842
Change in Inv. Value	1,434	86	277	3,267	-541	325
Less: Production Exps.	16,011	16,753	20,155	24,972	23,327	25,596
Net Realized Income	9,841	6,842	12,706	12,364	11,894	7,427
Sheridan County, Wyoming						
Total Cash Recieved	15,700	17,174	21,630	25,692	20,745	21,808
Livestock	12,504	13,874	17,848	20,804	15,107	15,981
Crops	860	866	1,040	1,834	2,227	1,867
Other Income	2,336	2,434	2,742	3,054	3,411	3,960
Govt. Payments	386	334	398	226	50	126
Imp. Inc. & Rent	1,950	2,100	2,344	2,828	3,361	3,834
Change in Inv. Value	3,071	688	-283	340	1,379	-1,495
Less: Production Exps.	13,043	14,218	16,507	19,088	19,727	20,154
Net Realized Income	2,657	2,956	5,123	6,604	1,018	1,654

the individual income tax, the motor fuel tax, the corporate license and the natural resource tax. There is tendency to depend more and more upon the coal severance tax for such revenues.

The Montana tax system for state and county jurisdiction by type of tax and maximum mill limit, is presented in appendix I-1, table B. Tables C and D, of appendix I-1 present detailed accounts of tax levies, revenues, rates, and valuations of Big Horn County (1960-1974). In general, those data show increased assessed valuations and decreasing tax levies, with time.

The following taxes exist in Wyoming:

General Tax Structure For Wyoming

a. Property Tax
b. Sales and Use Tax
c. Highway User Taxes & Fees
d. Natural Resource Based taxes
e. Alcoholic Beverage Tax
f. Cigarette Tax
g. Miscellaneous Revenue Sources:
   1) Insurance company taxes,
   2) Inheritance & Estate tax,
   3) Fish and Game license and other fees and unemployment compensation tax.

Additionally, Wyoming has special education-financing provisions including school levy, foundation program, and supplemental aid program. Highways and streets are financed through previousl mentioned taxes, but are supplemented by special improvement levies. Tax sources and distributions are made available in appendix I-1 (table E).

Sheridan County can rely on mineral production for only 17 percent of its tax base, whereas Wyoming counties on the average depend upon mineral production for 68 percent of the tax base. Still, historically, the assessed valuation for Sheridan County has been increasing: $37.1 million in 1965, $38.5 million in 1970, $45.6 million in 1974, and $57.7 million in 1978.

The city of Sheridan has also experienced increased assessed valuation, decreased mill levies, and only slightly increased taxes collected since 1970 (see appendix I-1, table F). The specific analysis of funds for 1974 in the city of Sheridan indicates the general funds at a 7.4 mill rate accounted for 57 percent of the total $228,978 revenues as indicated in appendix I., table F.

For the purpose of illustrating the mixture of taxes, the 197778 expected revenues of Sheridan and Sheridan County are shown in the table below. From these data, a picture is easily seen of the relative dependence on the local tax base for various revenue.

TABLE II-20.--Estimated revenue for Sheridan and Sheridan County 1977-78 ($000)

Source of Revenue		City of Sheridan Revenues	City of Sheridan Percent	Sheridan County Revenues	Sheridan County Percent
I.	Property Tax	163	7	324	11
	Licenses, Fees	534	22	95	3
II.	Sales	770	31	491	17
	Gasoline	180	7	138	5
	Cigarette	160	7	10	-
	Mineral Royalties	115	5	317	11
III.	Revenue-Sharing	94	4	137	5
IV.	Grants	284	12	959	33
	Coal Impact	-	-	150	5
	Miscellaneous	125	5	234	10
	Total, General Fund (less cash on Hand)	2,445	100	2,855	100

It is important to note that the general funds in the various levels of local government do not provide a complete picture of the total tax account. A number of important funding functions are provided through separate funds other than general taxation. For example, in Sheridan an additional $1.4 million is raised through the use of fees and grants for the water and sewer fund. In Sheridan County, $0.64 million is raised for the hospital and $0.36 million for the airport through taxation.

Data in Table II-21 illustrate the increases in expenditures and revenues for the City of Sheridan between 1966 and 1975.

Funding are raised within the local district, the county, the state, and also received from the Federal government. The primary source of school funding is the property tax. Six separate property tax levies can be assessed: state school, general county, county equalization, district qualifying, special district, bond, and interest. Of all property tax revenues raised in Wyoming, 75 percent are used for schools. Because approximately half of the property tax base is accounted for by mineral revenues, there is wide variation in the capacity of school districts to support schools with assessed valuation.

As is indicated in appendix I-1, table G, the two school districts being impacted in Sheridan County are poor, relative to the rest of the school

TABLE II-21.--Budgeted expenditures and estimated revenues for city of Sheridan, Wyoming, fiscal years 1966 and 1975

[Data are in current dollars. Source: Budgets for the city of Sheridan]

	1966 ($000)	1975 ($000)	Percent Change 1966-75
Budgeted Expenditures			
General Fund, Total	710	1,742	145.4
General Government [a]	68	162	138.2
Police Department	101	230	127.7
Fire Department	87	170	95.4
Streets and Alleys	301	205	- 31.9
Public Health and Sanitation	66	158	139.4
Parks and Recreation	21	219	942.9
Federal Revenue Sharing	--	302	---
All Other	66	296	348.5
Bond Sinking and Interest Funds	57	167	193.0
Cash and Reserve Funds	0	24	---
Subtotal	767	1,933	152.0
Water and Sewer	2,233	653	- 70.8
Total, Budgeted Expenditures	3,000	2,586	- 13.8
Estimated Revenues			
Transfers from State [b]	119	465	290.8
Other Nontax Revenue [c]	247	773	212.9
Property Taxes [d]	167	218	30.5
Cash Available	234	477	103.8
Subtotal	767	1,933	152.0
Water and Sewer Revenue	2,233	653	- 70.8
Total, Estimated Revenue [d]	3,000	2,586	- 13.8

a Includes general government, city attorney, city clerk and treasurer, cemetary, municipal court, engineering department.

b From gas, sales, cigarette, and use (beginning in 1974) taxes.

c Includes Federal revenue sharing during 1975.

d Excludes Policemen's Pension Fund.

districts in Wyoming. The State of Wyoming, however, has many prosperous school districts relative to national averages.

Property taxes account for only about half of school revenues. The remaining proportions are derived from various sources, including school lands income, oil royalties, motor vehicle registration fees, and general state appropriations. Most of these funds are placed in the state foundation program, for subsequent redistribution among the school districts. The source of funding for the school system, therefore, is quite diversified. Table H, in appendix I-1, demonstrates the proportion of revenues, according to source, for the two potentially-impacted school districts.

In terms of debt capacity, the total school system in Sheridan had a larger remaining debt capacity in 1975 than in 1974, with increased remaining debt capacity for school District 2 and decreased remaining debt capacity for School Districts 1 and 3. For 1976-1977, District 1 was at zerp percent of debt capacity and District 2 at 58 percent (compared with an average of 39 percent for all Wyoming districts).

<u>Tax Summary</u> - Each state within the impacted area has special provisions in terms of levies and mill rates, as well as special provisions, for intergovernmental flows to local units of government in the county, towns, and school districts.

In comparing Montana and Wyoming tax revenue systems, two differences are apparent. Wyoming has no personal income or corporate income tax structure, while Montana has no sales tax structure. However, there are numerous tax revenue systems which are common between Montana and Wyoming. Both states return funds to local levels of government and the property tax is the major source of revenue for each state.

Municipal and county governments rely on an extensive array of revenue sources, including a considerable proportion of funding from other than the municipal level. The major categories are: 1) revenues derived directly from local sources, 2) revenues received as sharped proportions together with state government, 3) revenues received as transfer payments from state or federal governments, 4) revenues received in the form of grants of categorical aid from state or federal governments.

In the first category, two basic kinds of funding can be identified: general property taxation; and a large number of use, service, license or penalty charges. The second category includes primarily such dividend revenues as sales tax, gasoline tax, and cigarette tax. In the third category, are general revenue sharing and the school foundation program (applicable to school districts). The fourth category includes a variety of grants-in-aid which can be categorized as primarily project grants or formula grants.

TABLE II-22.--Projected mine and ancillary employment through 1990, without Spring Creek mine; Big Horn and Sheridan Counties

	MINE EMPLOYMENT		ECONOMIC BASE EMPLOYMENT		ANCILLARY EMPLOYMENT		TOTAL EMPLOYMENT	
	Big Horn Co.	Sheridan Co.	Big Horn Co.	Sheridan Co.	Big Horn Co.	Sheridan Co.	Big Horn Co.	Sheridan Co.
1978	195	826	2,244	4,411	2,264	6,234	4,508	10,645
1979	153	596	2,202	4,181	2,346	6,290	4,548	10,471
1980	153	696	2,202	4,281	2,445	6,301	4,647	10,662
1981	210	696	2,259	4,281	2,573	6,511	4,832	10,792
1982	210	696	2,259	4,281	2,679	6,636	4,938	10,917
1983	210	696	2,259	4,281	2,783	6,759	5,042	11,040
1984	210	696	2,259	4,281	2,889	6,881	5,148	11,162
1985	210	696	2,259	4,281	2,996	7,003	5,255	11,284
1986	210	696	2,259	4,281	3,104	7,124	5,363	11,405
1987	210	696	2,259	4,281	3,213	7,253	5,472	11,534
1988	210	696	2,259	4,281	3,323	7,380	5,582	11,661
1989	210	696	2,259	4,281	3,434	7,503	5,693	11,784
1990	210	696	2,259	4,281	2,546	7,623	5,805	11,904

* Mine employment includes mine construction workers. Economic base employment includes miners, agriculture, manufacturing, Federal government, and part of transportation workers. Ancillary employment includes all other workers. Mine employees are estimated by county of residence.

5. ECONOMIC PROJECTIONS WITHOUT SPRING CREEK

Given the current economic activities in the two county area, and given the known expansion of existing mining activity, it is estimated that some growth will occur in the area without the Spring Creek mine being estabilished.

Table II-22 shows estimated projections of employment for the two counties between 1978 and 1990, without the Spring Creek mine. As indicated, Sheridan County is estimated to have a greater absolute growth rate in terms of total employment, for the period. Much of the growth would occur in ancillary employment as a result of other new mining ventures.

State, county, and school revenues and expenditures are made available in appendix I-2. It is estimated that the economic base in Big Horn County would be sufficient enough to provide more than adequate revenues for governmental entities. Sheridan County, on the other hand, would experience "short falls", indicating that the tax bases for the county and the school districts would be insufficient. Services and facilities needed would not be totally adequate, given budget constraints. Estimates for the growth rate in the number of students per county, given that the Spring Creek or other new mines are not established, is also made available in appendix I-2, given that the Spring Creek or other new mines are not established.

6. SEVERANCE TAX

The amount of severance tax generated in Big Horn County, ever without the Spring Creek mine, constitutes a large income for the State of Montana from Big Horn County. In 1978, approximately $28 million will accrue to the State of Montana. By 1990, without the Spring Creek mine, the severance tax (due to other projected mining in the county) will generate approximately $104 million. (Adjusted for future inflation via Chase Econometrics Model.)

7. CROW ECONOMICS

Government is the largest source of employment for tribal members. The single largest employer is the agricultural sector. The smallest sources of employment for tribal members are business, mining, and forestry occupations. Some Crow Indians are employed in existing coal mines adjacent to the reservation, specifically the Westmoreland mine, which is on Crow "ceded land". Crow Indians make up approximately one-half of the Westmoreland work force of 153 employees, based upon a ceded/coal production employment agreement.

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[1] All estimates in this section were taken from the computer model coal Town II. Montana State University, Bozeman, MT. Site specifics inconjunction with the NPRB EIS.

Unemployment is high on the Crow Reservation. Without question, unemployment rates are much higher than for the United States as a whole. This is reflected in the overall unemployment rate for Big Horn County (table II-15), two-thirds of which is covered by the Crow and Northern Cheyenne Reservations.

8. NORTHERN CHEYENNE ECONOMICS

Government is the largest source of employment for tribal members. The single largest employer is the agriculturial sector. Some timber production does occur in and adjacent to the Northern Cheyenne Reservation. Ranching operations exist over much of the reservation.

In 1973, the Bureau of Indian Affairs estimated that Indian unemployment ran as high as 50 percent. A study prepared by J. Whitefisher (1975), the Reservation's program officer, estimated that the Northern Cheyenne's unemployment rate varied from 41 percent of the available work force to a high of 70 percent during the winter months.[1] Unemployment is high, and cultural differences between the Indians and the non-Indians often prohibit, or discourage Indian employment in coal-related industries.

J. COMMUNITY SERVICES

Community services in the Birney-Sheridan area are currently being impacted due to population growth and increased demand for services. Expansion of existing services and provision of new services is lagging behind demand.

1. HOUSING

In 1976, Sheridan County had 7,446 housing units (table II-23). The City of Sheridan contained 71% of these, Dayton had 3%, Ranchester 2%, and Clearmont 9%. Together, these four urban areas contained 77% of the units. In Sheridan, as in other rapid-growth communities, the price of housing has increased because of low vacancy rates, rapid increases in demand, a limited building construction capacity, and difficulties in obtaining financing. Housing in Southern Big Horn County is virtually non-existant. The area is rural, dotted with a few ranch homes.

The types of housing units found in the Sheridan area are shown in table II-24. Major emphasis is on single family dwellings and mobile homes. Figure II-18 shows the age distribution of housing units. Only 30.5 percent of the housing units are less than 25 years old and many units probably require major maintenance expenditures.

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[1] J. Whitefisher, 1975. A Profile of Northern Cheyenne Reservation, Rosebud-Big Horn Counties, Montana.

TABLE II-23.--Housing units in Big Horn County and Sheridan County, 1970 and 1976

Location	1970[1]				1976[2]				Percent change, 1970-1976[3]			
	Occupied	Vacant	Total	Percent vacancy	Occupied	Vacant	Total	Percent vacancy	Occupied	Vacant	Total	Percent vacancy
Big Horn Co.	2,664	204	2,868	7.1	3,125	345	3,470	9.9	17.3	69.1	20.9	39.4
Hardin	920	70	990	33.8	1,154	102	1,256	8.1	25.4	45.7	26.8	-75.8
Lodge Grass	188	19	207	9.1	158	25	183	13.6	-15.9	31.5	-11.5	49.4
Other	1,556	115	1,671	6.8	1,813	218	2,031	10.7	16.5	89.5	21.5	57.3
Sheridan Co.	6,022	633	6,655	9.5	7,329	117	7,446	1.5	21.7	-81.5	11.8	-84.2
Sheridan	4,111	323	4,434	7.3	5,199	51	5,250	0.9	26.4	-84.3	18.4	-86.7
Dayton	([5])	([5])	[6]141	([5])	196	3	199	1.5	([5])	([5])	41.1	([5])
Ranchester	([5])	([5])	[6]74	([5])	150	2	152	1.3	([5])	([5])	105.4	([5])
Clearmont	([5])	([5])	[6]50	([5])	65	1	66	1.5	([5])	([5])	32.0	([5])
Other[4]	1,911	310	1,956	15.8	1,719	60	1,979	3.0	-10.1	-80.7	1.1	-81.0

[1] 1970 census
[2] 1976 special census
[3] Base year 1970
[4] Row and column data for 1970 for Sheridan County, Other does not total due to differing data availability. The 1970 Percent vacancy for Other is therefore overstated, as is the Percent change, 1970-1976.
[5] Data not available
[6] Derived from 1970 census population - 2.8 per household

Age of housing source: SAPA Housing Survey 1976

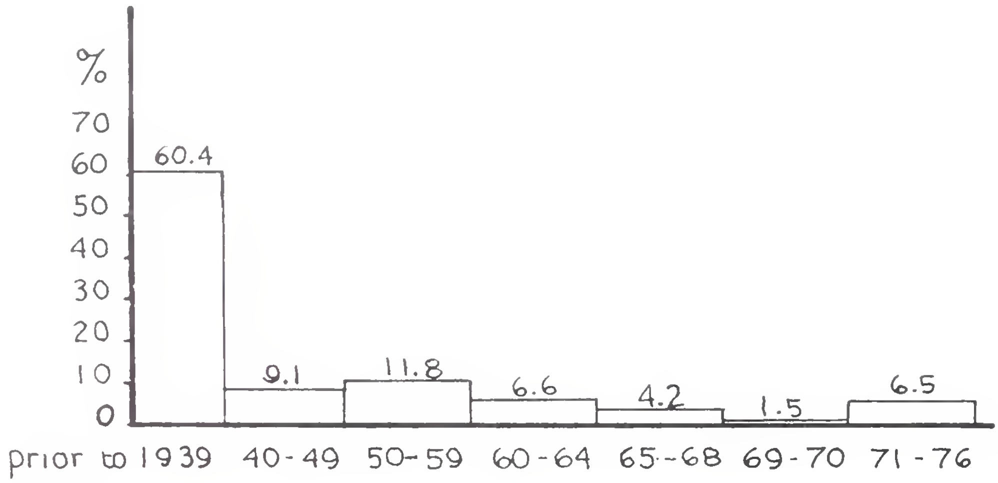

FIGURE II-18.--Ages of housing in Sheridan County.

Building Permits - Source: SAPA Housing Survey
Personal communication City Building Department

1965	15	1969	17	1973	29	August 1977 96
1966	47	1970	35	1974	40	
1967	18	1971	38	1975	89	
1968	23	1972	53	1976	112	

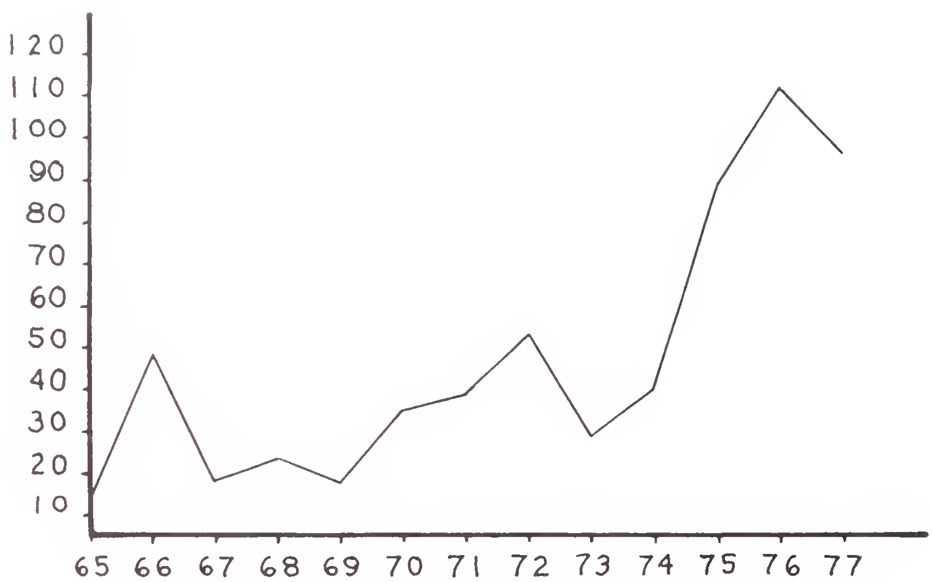

FIGURE II-19.--Building permits for new construction, Sheridan, 1965-77.

TABLE II-24.--Types of housing units in Sheridan area (in percent of total)

		Single family	2 Plex	3-4 Plex	5 or more	Mobile
Sheridan Area	1976	87.1	1.1	0.8	0.5	10.5
	1970	81.3	4.4	4.3	6.4	3.6
Wyoming	1970	74.3	6.1	4.5	6.1	9.0

Source: Sheridan Area Planning Agency Housing Survey 1976

Much of the vacant housing is substandard and occasionally a high percentage of the substandard housing is occupied. Table II-25 shows housing conditions in Sheridan County.

The only low-income houses in existance at the present time are those covered by the 103 Farmers Home (FmHA) loans/subsidies on existing single family dwellings. According to the FmHA Sheridan office, most houses under $30,000 are in such poor condition that the agency cannot finance them. In 1976, of the people qualifying for a subsidy, only 30 loans could be made.

Housing construction has increased greatly in the last few years (Fig. II-20). The number of units is understated, in that a single permit is issued for a four-plex. The number of mobile homes increased from 307 in 1970 to 785 in 1976, and to 885 in 1977--an increase of 288 percent in seven years.

A study by the Department of Economic Planning and Development (DEPAD) indicates that 34% of all households are renters, but that 60.3% of households in need of assistance are renters. Renters are especially vulnerable to the inflating housing market. A homeowners' payments will remain constant; only the taxation will reflect the boom. Rental rates, on the other hand, will rise with the demand.

Nearly 40% of the families in need of assistance are homeowners. Many of them probably are elderly. These families may face difficulty in meeting the rising tax burden, and in addition, may be unable to maintain their homes adequately. Eighty percent of the elderly needing assistance live in substandard housing.

2. WATER

a. Sheridan City

Sheridan has a municipal water system serving the town and some areas beyond the city limits. The system is engineered to handle the present population and some growth. The treatment system can produce water at the rate of 15 million gallons per day (MGD) for short periods. A 1974 engineering study (Black & Veach) indicated that

Table II-25.--Housing Conditions Sheridan County

[Source: Sheridan Area Planning Association (SAPA) 1976 Housing Survey]

	Total	Standard number[1]	Percent of row total	Substandard number[2]	Percent of row total
County total--------	7,446	7,278	97.7	168	2.2
Occupied----------	7,329	7,754	98.9	75	1.0
Vacant------------	117	24	20.5	93	79.4
County rural total--	1,065	1,008	94.6	57	5.3
Occupied----------	1,014	1,000	98.6	14	1.3
Vacant------------	51	8	15.6	43	84.3
Sheridan total------	5,250	5,180	98.6	70	1.3
Occupied----------	5,199	5,168	99.4	31	0.5
Vacant------------	51	12	23.5	39	76.4
Ranchester total----	152	147	96.7	5	3.2
Occupied----------	150	147	97.9	3	2.0
Vacant------------	2	0	0.0	2	100.0
Dayton total--------	199	194	97.4	5	2.5
Occupied----------	196	194	98.9	2	1.0
Vacant------------	3	0	0.0	3	100.0
Acme total----------	50	42	83.9	8	16.0
Occupied----------	49	42	85.7	7	14.2
Vacant------------	1	0	0.0	1	100.0

[1] Standard includes mobile homes - standard or minor rehabilitation
[2] Substandard - needing major rehabilitation or delapidated

following deficiencies in the Sheridan water system:

1) Inadequate pressure in the NE and NW corners of town, and

2) Inadequate distribution in the NorthCentral area

The report indicated $1.395 million for improvements including an additional 2 MG storage and several improvements in the distribution system.

Substantial growth would most likely outstrip the treatment capacity, first by raising the 8 MGD peak use to a level in excess of the 10 MGD capacity. Such growth would necessitate additional water rights and/or storage. At the average yearly use rate of 265 gallons per capita per day (gpcd) (3.5MGD/13,200), an additional 5,600 people would raise the average yearly consumption to MGD, equaling the appropriation. SAPA projections indicate this population occuring within 5-10 years.

Water system improvements were rated third most important in the Sheridan County Needs Inventory (SAPA).

Table II-26 provides data for existing water systems in both Sheridan and Big Horn counties.

b. Dayton

The town water system supply is considered adequate for existing and forseeable uses. The treatment plant is generally adequate, with minor modification, except that the plant must meet EPA standards for filter backwash which will require a settling pond. The storage is inadequate to provide for peak demand, fire flow, and emergency reserve. The distribution system is undersized in several areas termined number of leaks which constitute a major problem. The system was designed for a population of 450. Current population is in excess of 500. Any major growth will place additional strain on the system, probably requiring major investment.

c. Ranchester

The town water system is under great stain due to rapidly increasing population. The supply and treatment are adequate except that the pumping capacity is too low. Only part of the storage is actually usable due to low pressure. Fire flow and domestic requirements indicate a need to triple the storage capacity. Portions of the distribution system are old, much of it is undersized and the system needs engineering, e.g. looping of lines.

d. Rural

Other areas of the County rely on individual wells. It is

TABLE II-26.--Existing water systems

[Source: Big Horn Co. - Montana Department of Health and Environmental Science
Sheridan Co. - Sheridan Area Planning Agency (SAPA)
Powder River Areawide Planning Organization (PRAPO)]

	Present Population	Source	Appropriation MGD	Treatment cap MGD	Storage cap MGD	Distribution cap MGD	Av Sum Use MGD	Av Yr Use MGD	Peak Use MGD	Supply Presently Adeq.
Big Horn County										
Decker		private wells	-	-	-	-	-	-	-	Yes
Hardin	3,050		no filing	2.0	0.5	NA	NA	0.152	1.638	Yes
Lodge Grass		well 150 gpm .216 MGD	no filing	0.36	0.3	NA	0.05-.067	NA	NA	Yes
Sheridan County										
Sheridan	13,200	Big Goose Creek	5.0	10.0	6.0	15.0	NA	3.5	8.0	Yes
Dayton	500	Tongue	0.007	0.57	0.075	NA	NA	0.129	NA	Yes
Ranchester	416	Tongue	10.33	0.2	0.08	NA	NA	0.059	0.109	Yes

\- Not applicable
NA Not available

difficult to obtain good water east of Sheridan due to poor chemical quality from coal aquifers. The major problem elsewhere is the possible wells by septic tank effluent. The County residents rated water improvements third out of 17 in the Needs Survey (SAPA).

e. Decker

The area is served by private wells. Groundwater is available from alluvium and coal seam aquifers. Generally the upland water is of poor quality for human consumption. The coal aquifers or Tongue River alluvium are most commonly used for domestic use due to better quality. Some of these sources may meet Public Health standards for drinking water. The flows from existing wells indicate sufficient availability of water for additional domestic use if quality is sufficient.

3. WASTEWATER TREATMENT

a. Introduction

The exact state of adequacy of some sewage treatment facilities is rather difficult to describe. EPA standards required municipal treatment to be in effect by July of 1977. EPA has 75% matching money for construction of municipal treatment facilities. However, there has been a history of insufficient funding to implement the program. The Wyoming Department of Environmental Quality, which administers part of the EPA program, has taken the stand that the 1977 standards will not be enforced until EPA provides the money for facility construction. As a result, some towns are technically in violation. It is difficult to determine when the discharge standards will be enforced, but it is certain that at some time they will be.

A brief note is in order on the methods of waste treatment. Most small towns use a stabilization pond, or lagoon system. This type of treatment is inherently unable to consistently meet EPA 1977 standards. The systems are used, because they are inexpensive not because of effective treatment. The same problem of enforcement applies here also, at some time the 1977 standards will be enforced and facilities will have to meet them. In the mean time, towns will be allowed to continue existing operations.

b. Sheridan City

The city operates a secondary treatment facility using a trickle filter process. The present system is inadequate. Using state standards for per capita flow, the sytem is capable of treating sewage for 12,500 people at the design capacity. The system peak capacity is 5.2 MGD but cannot be operated on this basis indefinitely.

The operator of the system reports that it is functioning well for all parameters except the removal of BOD (biological oxygen demand).

This is considered a major problem by state and federal water quality officials. PRAPO (powder River Areawide Planning Organization) water quality monitoring indicates extremely high bacteriological levels below the plant discharge. Infiltration and inflow are a problem with the collection system which effectively reduces the treatment capacity.

Sewage treatment was rated fifth of 33 items in priority in the Sheridan County Needs Survey (SAPA).

c. Ranchester

The existing treatment system is inadequate. The present lagoon is substantially undersized. There is a substantial infiltration/inflow problem with the collection system. Standard per capita sewage flows range between 100-150 gpcd. Measurements taken on the system yielded flows equivalent to 736 gpcd. This excess water chokes the treatment system and reduces its effectiveness still further. There is apparently a problem with malfunctioning septic tanks on the north edge of town. The Needs Survey rated sewage improvements in the top three items. The PRAPO study recommended a three-cell aerated lagoon as the most cost-effective solution. Total construction cost would be about $310,000.

The Comprehensive Plan indicates that the sewage treatment system of Dayton is generally considered adequate for existing and near future conditions. However, the one-acre/100 people standard rule indicates that it is significantly undersized. The existing system does not discharge. Analysis indicates that after accounting for evaporation, more than two-thirds of the flow is seeping out of the lagoons. The town could be required to either seal the ponds or conduct an extensive monitoring program to determine the effect of the seepage on the groundwater.

The collection system is fairly new and is in good shape. This type of treatment facility is unable to consistently meet discharge standards. The PRAPO study indicates the most cost-effective method would be to construct a three-cell aerated lagoon at a total construction cost of $260,500.

d. Sheridan and Big Horn Counties

The unincorporated areas of Sheridan and Big Horn counties are served by individual septic systems. Without codes and a permit system, many systems may be improperly designed, installed, or operated. A substantial risk is present in the potential contamination of water and the surfacing of untreated sewage. Seventy percent of the Sheridan County residents indicated a need for improved facilities. Table II-27, although somewhat incomplete, covers the various kinds of sewage systems in both Big Horn and Sheridan counties.

TABLE II-27.--Existing sewage systems

[Sources: Big Horn Co.--Montana Dept. of Health and Environmental Sciences
Sheridan Co.--Sheridan Area Planning Agency (SAPA)
Powder River Areawide Organization (PRAPO)]

	Present Population	Type of System	Treatment Capacity (MGD)	Collection Systems Capacity (MGD)	Peak Treatment flow (MGD)	Average Flow (MGD)	Number of cells	Acreage of cells	Discharge
Big Horn Co.									
Decker	NA	Septic Tanks	-	-	-	-	-	-	-
Hardin	3,050	Municipal	0.249	NA	0.425	0.30	2	NA	Big Horn River
Lodge Grass	NA	Municipal	0.08	NA	NA	0.08	2	11	Little Big Horn River
Sheridan Co.									
Sheridan	15,200	Municipal	NA	NA	4.0	2.0	(Secondary	treatment)	Big Goose Creek
Dayton	500	Municipal	NA	NA	NA	0.032	2	25	Tongue River
Ranchester	416	Municipal	0.0465	NA	NA	0.25	2	3.2	Tongue River

4. SOLID WASTE

a. Sheridan City

The City of Sheridan has a sanitary landfill of 56 acres which is also available to rural residents. The Sanitation Department estimates that the site will last up to ten years at the present rate. The site and equipment are considered adequate for at least the short term.

b. Sheridan County

The County does not have a landfill. Rural residents either use municipal landfills or traditional dumps. The comprehensive plan suggests a multicounty manangement study and the possibility of remote areas being served by a joint facility rather than one per county.

The towns of Ranchester and Dayton both had landfills which have been closed. This is probably due in part to new standards which took effect recently. The towns now haul to the Sheridan landfill. Neither town has filed an application for a landfill permit, which suggests that there are no plans to open or reopen either site.

c. Big Horn County

The Decker area is currently using an unlicensed dump. A tri-county solid waste management operation will cover the area within a year or two. This will be funded by a Montana Coal Board grant and will meet new state licensing regulations taking effect in the Fall of 1977.

5. SCHOOLS

a. Sheridan County

Three unified school districts serve Sheridan County. District 2 which includes Sheridan, has received the greatest increase in enrollment. District 1, including Ranchester and Dayton is also experiencing growth. District 3, on the eastern side of the county, is not having overloading problems but is plagued with deteriorating structures. This district is not expected to receive any impact from the Spring Creek mine and will not be discussed further.

(1) District 1

Table II-28 shows the basic statistics for the District for 1976. Since then, approximately 60 new students have been added and the total number of teachers increased to 54. Many of these teachers have been hired for new programs such as learning disabilities, or expanded programs such as kindergarten.

The District expected to break ground in November, 1977 on

TABLE II-28.--School statistics for Big Horn County, Montana, and Sheridan County, Wyoming

	Class room	Gym	Multi-purpose	Enrollment	Teachers	Student/ Classroom Ratio	Student/ Teacher Ratio	Expansion Program	Notes
Big Horn County									
Hardin									
High School 9-12	22		yes	551	33.0	25.0	16.6	yes	remodel and addition
Jr. High School 7-8	14			275	19.5	19.6	14.1	yes	new junior high school
Intermediate 4-6	13		yes	236	16.0	18.1	14.7	yes	remodel and addition
Primary 1-3	17			402	18.0	23.6	22.3	yes	remodel and addition
Crow Agency K-6	14	recreation		235	23.0	16.7	10.2	yes	remodel and addition
Fort Smith K-6	8	recreation		75	7.0	9.3	10.7	no	out of study area
Lodge Grass									
High School 9-12	17		yes	153	17.2	9.0	8.8	yes	new high school
Elementary K-8	17	in high school		339	27.8	19.9	12.1	yes	take old H.S. for 4-8 renovate existing building
Wyola									
Elementary K-8	11	yes		96	14.0	8.7	6.8	no	
High School 9-12	17	in elem.		56	6.5	9.3	8.6	yes	new high school '78
5 Rural Elementary K-8	11	3Y 2N		141	12.5	12.8	11.2	no	1 out of study area
Sheridan County									
School District 1									
Big Horn K-12	20	yes		279	23	13.9	12.2		fair condition
Dayton 7-12	13	yes		206	23	12.9	12.2		good condition
Slack 1-5	1			9	1	9.0	9.0		fair condition
Ranchester K-6	8			186	9	23.2	20.6		poor condition
School District 2									
Sheridan Sr. 9-12	48	yes	yes	1,126	60.6	23.4	18.6		parts are delapidated to good condition
Central Jr. 7-8	18	yes	yes	420	19.2	23.3	21.9		parts are good to deteriorated
8 Elementary K-8	76	5	7	1,783	76.4	23.4	23.3		3 delapidated 3 deteriorated 2 good condition
Special Education	7			72	6	10.2	12		good condition
Special Services	7				10.9				
School District 3									
Clearmont K-12	13	yes		125	13	9.6	9		poor condition
Arvada K-6	2			19	2	9.5	10		poor condition
Parochial School 1-8	10	yes		223	10	22.3	23		excellent to good

two new elementary schools at Big Horn and Ranchester. These schools are seen as the most urgent need. There are many other needs and problems in the other schools. Junion-Senior High School in Dayton has reached capacity, and needs space. The Big Horn School needs work done, such as a new furnace and wiring. The elementary school in Ranchester needs structural work, wiring, and space. The community hall in Dayton is being leased for the second grade. In short, the District is in great need of money for capital construction.

The two new elementary schools are costing more than the allowable bonding capacity of the District. Of the $1.35 million needed, only $945,000 can be bonded. The District has received a public works grant from the Federal government for $100,000 and is selling land for $80,000. The remaining difference is still unavailable. The board is planning to request assistance from state agencies.

(2) District 2

Since 1976, the District has added approximately 100 students and five or six teachers. The elementary schools have a little space; the Junior High is at capacity; and the High School could take 200 to 300 more students.

The District is selecting an architect for a new two-or three-section elementary. (A "two-section" would have two classes of each grade). The Junior High needs expansion, whether it remains as 7th or 8th grades or adds the 6th or 9th grade. The District is hopeful that both construction projects can be accomplished with available funds.

The bonding capacity currently available is about $1.8 million. A state entitlement can be drawn for seven years ahead, which would yield approximately $1.5 million. This gives the District about $3.5 million to try to meet the most urgent needs. In addition to capital expenditures, the operating expenses are needed for maintenance, busing and administration offices. The District is currently engaged in extensive busing to equalize the load on schools.

6. HEALTH CARE

a. Health Care Facilities

The Sheridan County Hospital, completed in 1953, serves as the regional health care center for northeastern Wyoming and southeastern Montana. The facility is severely strained by a 43% increase in admissions from 1971-1976, and 128% increase in out-patient visits. Most functions of the hospital are cramped, or inadequate. The emergency

room has experienced a 508% increase in use since 1965, and is in critical need of space. Surgery needs two or more operating rooms and a recovery area, and the laboratory and radiology sections need space.

A new 26-bed hospital is located in Hardin. It is well equipped for its size, with coronary care, surgery, and obstetrical units.

The Indian Health Service operates a hospital at Crow Agency for both reservations. An out-patient clinic is also located at Lame Deer.

Ambulance service in Sheridan County and the Decker-Southern Rosebud County area ia provided by funeral homes in Sheridan with two ambulances and a backup unit. Big Horn County employees include three salaried, trained staff to operate two ambulances. The Indian Health Service provides ambulance service on the reservations.

b. Health Care Personnel

Since Sheridan serves as a regional medical center, it is well supplied with physicians for the county's needs. Big Horn County is considered to need five to six more doctors to meet the normal standard of one doctor per 1,222 of population.

c. Nursing and Retirement Homes

The Eventide nursing home operates in Sheridan. This facility has a capacity of 120 and an average staff size of 80. The Hardin hospital has a 34 bed nursing home wing. Another 22 bed home provides for those needing less attention.

Several housing developments for the elderly are planned or under construction. Taken together, these facilities will probably meet the needs of the sizeable senior citizen population of Sheridan County. The existing facilities in Big Horn County have short waiting lists and are therefore considered to be adequate.

7. LAW ENFORCEMENT

a. Sheridan City

The Police Department and jail are located in the City Hall basement. The department would like to move the facility away from other city functions, possibly to a joint city-county facility. The jail is, at times, too small for the number of prisoners. No off-street parking exists for personnel or visitors.

The comprehensive plan recommended that a new structure be built, a juvenile officer and a woman officer be hired, and personnel

and equipment be added as the population increases.

b. Ranchester

The town of Ranchester has a full-time and a part-time marshall. The marshall uses his home as an office and makes use of the county jail. Assistance is provided by the County sheriff. The residents of Ranchester largely felt a need for more, better trained and equipped policemen. (Needs Survey, SAPA) An office for the marshall was the basic recommendation from the comprehensive plan.

c. Dayton

The town is provided part time service by the County sheriff's office. Law enforcement was the greatest need identified by the Needs Survey. The comprehensive plan recommends a full time deputy sheriff be stationed in Dayton.

d. Sheridan County

The Sheriff's department covers all unincorporated areas of the county. The office is housed in a 1913-vintage building containing offices, laboratory, interrogations rooms, and jail. The building is shifting due to poor soil conditions and therefore needs replacing. There is insufficient space for additional personnel.

The department is considered understaffed. At present, the department can only respond to complaints and provide assistance. No patrolling is possible. The National Standard of officers per 1,000 people is 2 and for Sheridan and Sheridan County, inclusive, is 0.79, lowest in the state. Sheridan County officers are also the lowest paid in the state. If the personnel can be obtained, there will be a need for equipment for them. In any case, training, administration, and equipment replacement must be funded. The immediate needs identified by the county comprehensive plan include remedying the above-mentioned problems and hiring three new officers and a dispatcher. Eventually, the department would like to provide full-time deputies in the towns and continue upgrading service.

Sheridan County is served by twelve rural fire districts, a county crew at the airport, and city fire departments. The Sheridan fire department is considered adequate. Major improvements are underway in the water system to improve pressure and extend water to newly annexed areas. The major problem centers around the single station which is poorly located and reduces response time to outlying areas. The department would like to close the present station and construct two or three new ones. There is also a need for training areas. Sheridan has mutual aid agreements with the surrounding RFD's, the County airport fire station and the VA hospital. The city is purchasing a new aerial truck, and the county is getting a crash truck at the airport.

Dayton has a volunteer fire department with two men on call at all times. The district owns two trucks, a 300 and 600 gallon pumper. The water system is deficient, as noted earlier.

Ranchester has a 20 man volunteer department. Two trucks are owned by the district which includes the town. The water system deficiencies are noted on page II-70.

e. Big Horn County

The offices of the County Sheriff and the Hardin police recently merged. Except for the reservation police force, the Sheriff provides all police protection to the County. One deputy is half time constable in Lodge Grass. Another deputy and a truck are stationed in Lodge Grass. There is currently no resident officer in the Decker area. The area has had such an increase in problems and the serving of papers that it is considered imperative to station an officer there. Additional funding would be required to provide an officer for Decker.

The Decker area is covered by a volunteer department. The County has one 1,000-gallon pump truck stationed at Decker. Additional fire equipment is available at the mines but may not be available outside the immediate mine area.

K. LAND USE

1. PRESENT USE

The 4,420 acres of land within the permit area are presently being utilized for livestock grazing, wildlife habitat, watershed, and, to a small extent, outdoor recreation. No farmsteads or residences are located within the permit area, nor is the permit area traversed by any public road or utility right-of-way.

The land surrounding the application area is also thinly populated and rural in character, the predominant use being livestock grazing. The Decker coal mine, in operation approximately 5 miles to the southeast, contrasts with this pastoral landscape. The small community of Decker, south of the Decker mine, provides some clustered residences and commercial services. Scattering of new residences (both temporary and permanent) has begun on the rural lands surrounding the Decker-Spring Creek area.

Tables II-29 and II-30 provide acreages by major use and ownership categories for Big Horn County, Montana and Sheridan County, Wyoming. The permit area is similar to the broader region in grazing emphasis and in the small share of agricultural, urban, industrial, and wooded lands.

TABLE II-29.--Land use in Big Horn and Sheridan Counties

[Source: Northern Great Plains Resources Program: Surface Resources - Regional Profile Draft, February 1974]

Big Horn County	Acres	Percentage of County Area
Big Horn		
Land Area	3,214,020	99.35
Water Area	21,180	0.65
Total County Area	3,235,200	100.00
Irrigated Cropland	48,400	1.50
Non-Irrigated Cropland	246,394	7.62
Total Cropland	294,794	9.12
Pasture and Rangeland	2,708,604[1]	83.72
Forest and Woodland	335,874[1]	10.38
Urban and Built-up areas	11,979[2]	0.37
Sheridan County		
Land Area	1,613,860	99.59
Water Area	6,620	0.41
Total County Area	1,620,480	100.00
Irrigated Cropland	60,801	3.75
Non-Irrigated Cropland	57,690	3.56
Total Cropland	118,491	7.31
Pasture and Rangeland	1,191,328[1]	73.52
Forest and Woodland	329,179[1]	20.31
Urban and Built-up Areas	37,525[2]	2.32[3]

[1]The sum of the acreages by use exceeds the total county area due to double counting of pastured woodlands.

[2]Includes residential, commercial, industrial, and transportation uses -- does not include strip mines, gravel pits or borrow pits.

[3]Meadowlark 1978, reported 20.29% for this category, including mining as an industrial use.

TABLE II-30.--Land ownership in Big Horn and Sheridan Counties

[Sources: USDA SCS - 1973 Conservation Needs Inventory for Land Resource Planning Big Horn County, Montana and Meadowlark, 1978]

	Percent
Big Horn County	
Government owned lands:	
(a) Federal	1.0
(b) State	2.6
Private and Indian owned lands	96.0
Urban owned lands	0.4
Total	100.0
Sheridan County	
Government owned lands:	
(a) Federal	28.3
(b) State	7.9
(c) Local	0.7
Sub Total	36.6
Privately owned lands	63.4
Total	100.0

2. LAND USE PLANNING

a. Federal Planning

The administration of Federally owned minerals, including mineral fuels, is the responsibility of the U.S. Bureau of Land Management (BLM). In the Spring Creek area, BLM administers a relatively small land-surface area but a much larger acreage of Federally-owned coal. Much of this Federal coal, therefore, is overlain by land in private ownership. The BLM is required to develop land-use plans, called Management Framework Plans (MFP's), for lands and resources under its care. Such an MFP has been developed for the Decker-Birney Planning Unit, within which the Spring Creek mine is proposed to be developed. The company's mining permit application, under analysis here, is compatible with the MFP recommendations for the Decker-Birney Planning Unit.

b. Local Land Use Planning

(1) Sheridan County

Land-use planning is relatively new to Wyoming. The state

has mandated subdivision regulations at the county level. A law, requiring local comprehensive plans, was very weakly worded, requiring only that a local government "may consider" certain topics and "shall consider" a very few. Recently, the legislature passed a bill which ultimately set up a housing board to provide low interest mortgages for housing. The target group for these mortgages is lower-middle and middle income people.

Sheridan County's response to the mandated planning was to form the Sheridan Area Planning Agency (SAPA), a council-of-governments organization that provided planning services to all towns and to the county. SAPA worked with the planning commissions for Ranchester, Dayton, Sheridan, and Sheridan County. SAPA produced a number of reports and studies culminating in comprehensive plans for each town and the county. The County Commissioners disbanded SAPA in 1977.

A small group was retained to "implement" the plans and obtain grant money. This has left no one but the planning commissioners to do the daily work on subdivisions, plats, parks, streets, and the numerous other projects coming before the board.

(2) Big Horn County

Like Wyoming, Montana is new to land use planning. Local governments are permitted to plan and zone within their jurisdictions but are not required to do so. Big Horn County currently has a consulting firm retained to work with the planning commissions, as staff and to seek grants. The county produced a "comprehensive plan" in 1972, which was essentially documentation of the need for a plan, rather than a plan itself. In October 1977, the County Planning Commission proposed a zoning package to try to manage the growth in the Decker area. A hearing has been held, but no schedule has been set for adoption.

At present two new towns are under consideration in the Decker area. One developer has selected a site near the Tongue River Reservoir and another is proposing a site along Route 314 north of the Decker mine. Plats have not yet been approved by Big Horn County so the outcome of these developments is uncertain. A problem which faces any developer of a town or residential subdivision is locating a suitable site in the area which is not underlain by strippable coal.

L. TRANSPORTATION SYSTEM

1. HIGHWAYS

The Spring Creek area is accessible from the north and south by Montana Federal-Aid Secondary Route 314 (Route FAS 314), which is a continuation of Wyoming Secondary Route 338 connecting to U.S. Route 87 and Interstate 90. Route FAS 314 is an all-weather road that starts at the Montana-Wyoming line and runs generally northward about 33 miles

to its junction with U.S. 212, which is the only east-west highway across southeastern Montana. Because most roads follow stream valleys, travel between some points may be very indirect.

From the State line to a point about 5 miles north of the Decker area, Route FAS 314 has an asphalt surface; beyond that point the surface is coated with crushed clinker or gravel. The surface of the asphalt segment of the road is 28 feet wide, and the road has a design speed of 60 miles per hour. Traffic in the Decker-Spring Creek area has increased substantially in the last several years. Figure II-20 also shows traffic levels above 600 vehicles per day on FAS 314. This highway is one of several proposed for reconstruction by the Highway Department. Although Route FAS 314 still functions as a primary farm-to-market facility, most of the current use represents daily round trips by mine employees living in the Sheridan area.

Relocation of 5.07 miles of FAS 314 is proposed by the Decker Coal Co. to make way for the North Extension of the Decker mine. The relocated section would be moved eastward along the shore of the Tongue River Reservoir and result in a lengthening of the route by 1.39 miles. The relocated section would have a length of 6.46 miles, from near the existing Decker coal loading loop to a point about one mile north of the mouth of Spring Creek. The rail spur to serve Spring Creek would lie to the west, or within the curve, of the proposed relocation route. Engineering designs of the rail spur and highway are being made separately, but both are constrained by the mine on the west and Tongue River Reservoir to the east. The Montana Highway Department is assisting Decker's consultants with the design but the Department has not announced a date of design completion.

2. RAILROADS

Figure II-21 shows the regional rail system serving the area in which the Spring Creek mine is located. A railroad spur approximately 19 miles long connects the West Decker mine with the Burlington Northern main line at Dutch Junction, about 5 miles east of Sheridan. This spur is used primarily to transport coal from the mine and, secondarily, to transport materials and equipment to the mine. Current traffic on this spur is approximately 3 unit-trains per day originating at the Decker mine. The proposed 16-mile extension to serve the Spring Creek mine would join the existing spur just south of the Decker mine loading loop.

The existing rail spur crosses FAS 314 at grade level south of the Decker mine. Public pressure has been focused on the problem of hazards and delays created by coal trains at this crossing and has resulted in plans by the Montana Highway Department to construct a grade separation. This project is planned for bid-letting in 1981 and should require about a year for construction.

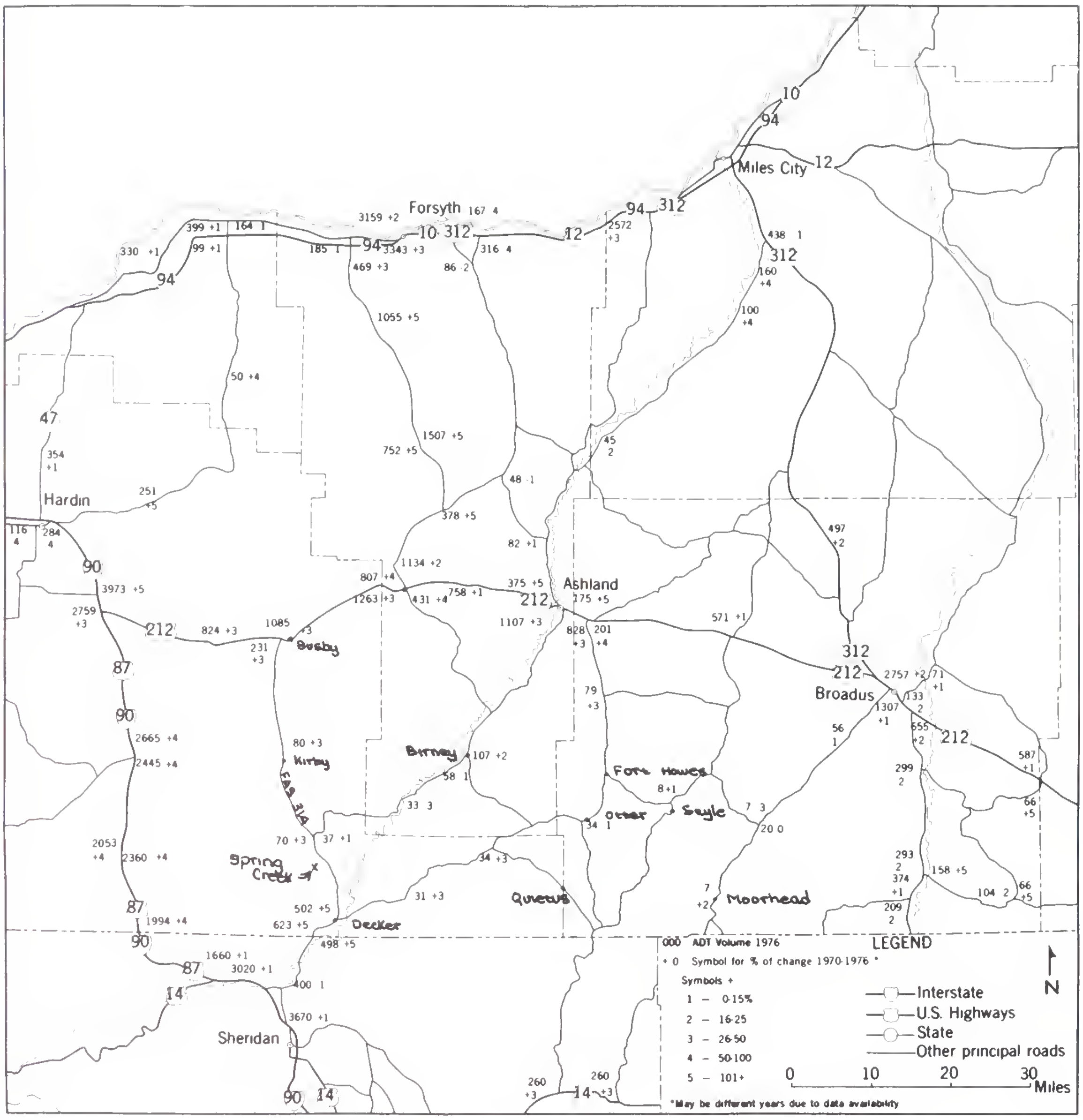

FIGURE II-20.--Average daily traffic on regional roads and highways.

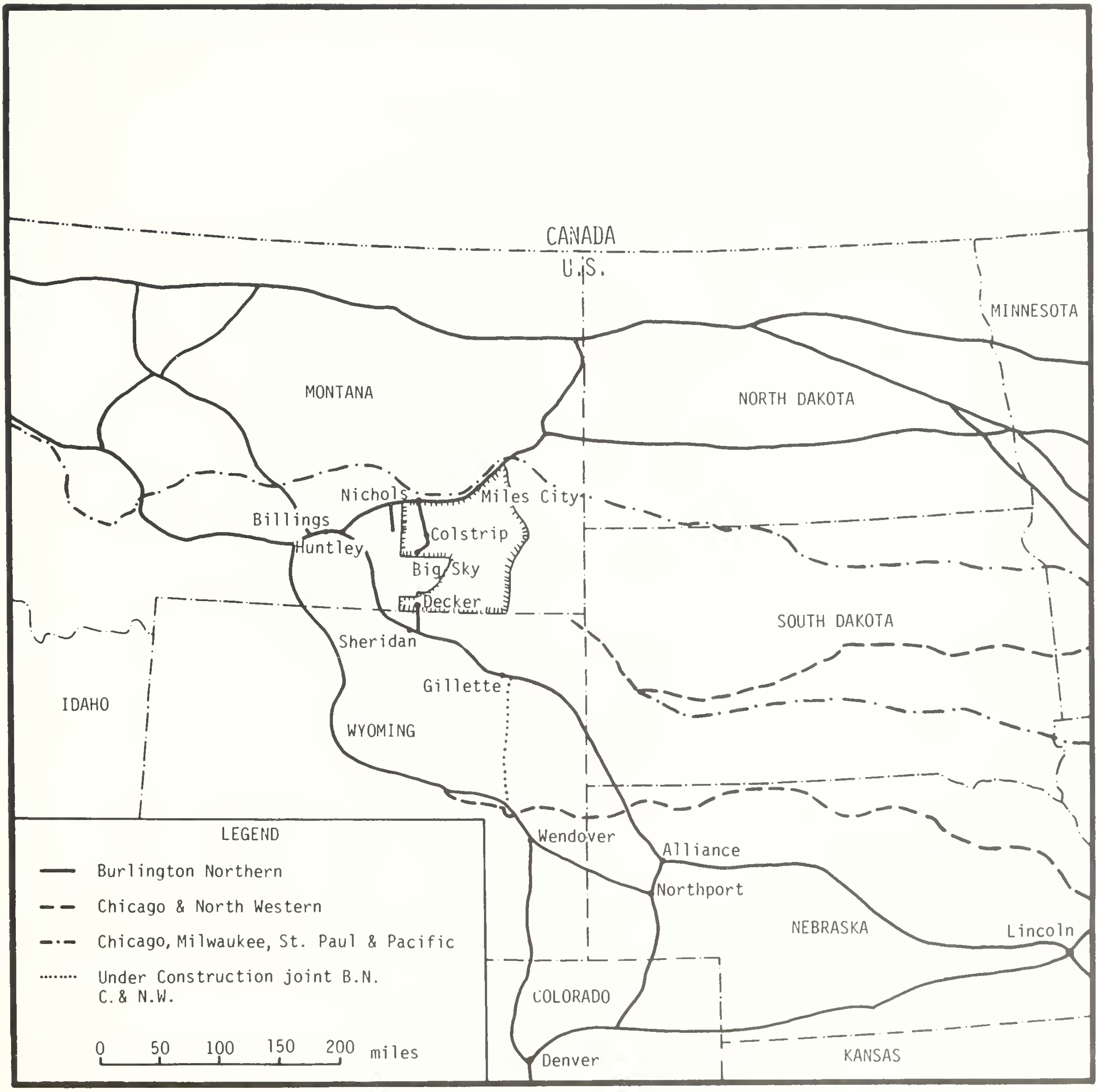

FIGURE II-21.--Major railroads serving the Powder River region.

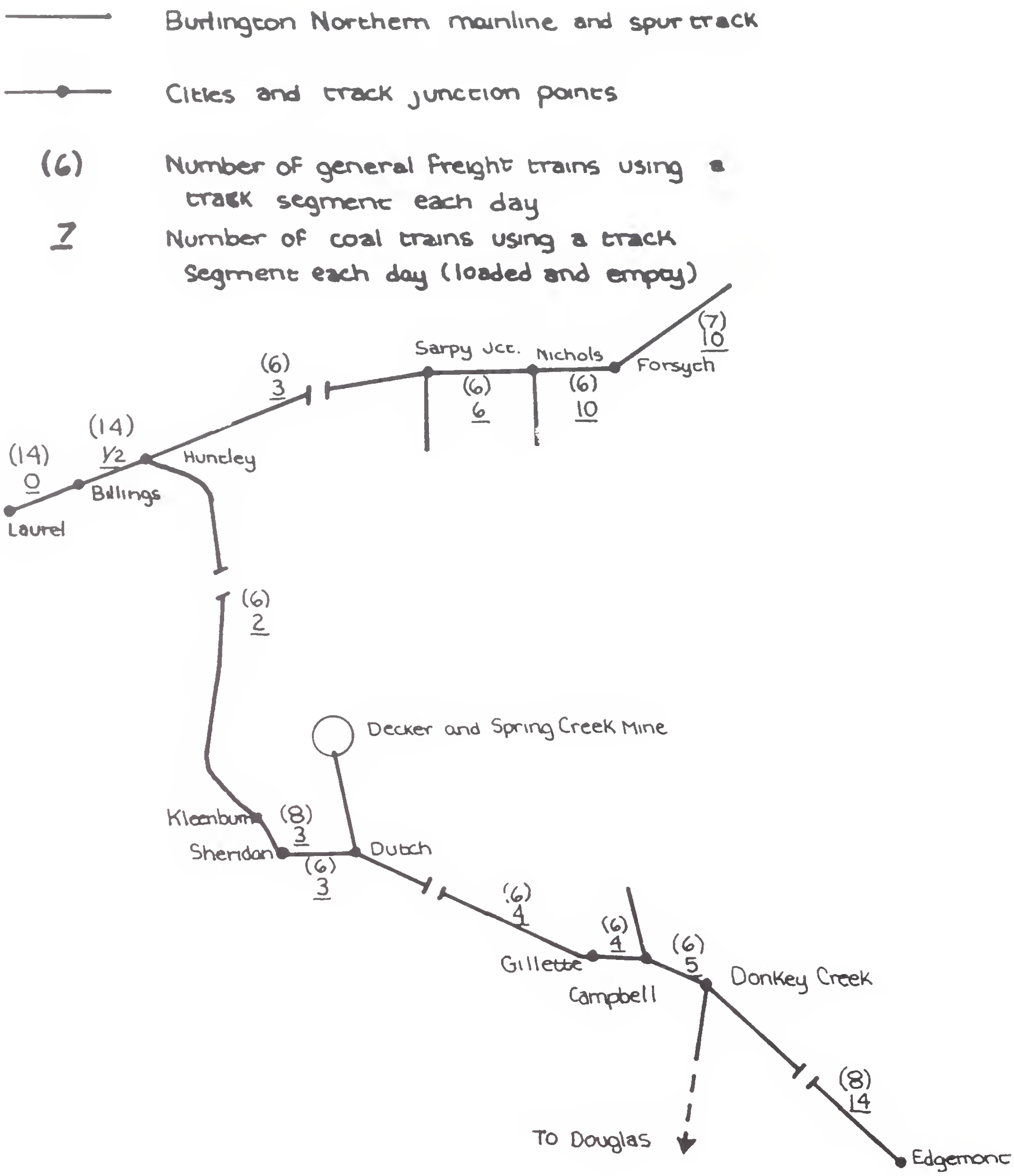

FIGURE II-22.--Traffic of the rail system serving the proposed Spring Creek mine, 1977.

Figure II-22 provides a schematic view of rail traffic on the system which would serve the proposed Spring Creek mine. From Dutch Junction, where Spring Creek trains would join or leave the main line, to the Sheridan area there are currently between 9 and 11 daily trains. An average of 10 trains per day move eastward from Dutch Junction through Gillette. At Donkey Creek Junction, additional coal traffic increases the load to 22 trains per day.

Line capacity in 1977 for the main line between Huntley, Montana, and Alliance, Nebraska, has been estimated by the Interstate Commerce Commission at 25 trains per day. The segment east from Donkey Creek is operating near capacity now. The Burlington-Northern is engaged in a 5-year program of facility improvement which involves this track segment. Burlington-Northern anticipates that by 1980 capacity will be raised to 60 trains per day. At the same time the rail link under construction between Donkey Creek and Douglas, Wyoming will have been completed providing an alternate route with a capacity of approximately 40 trains per day.

Table II-31 provides a comparison of 1977 rail traffic with expected increases for the various segments by 1981.

TABLE II-31.--Rail traffic projections for selected Burlington Northern line segments

[Source: Office of Vice President, operations B.N. Inc., St. Paul, Minn. November 7, 1977]

	Trains per day 1977*		Trains per day 1981*	
Line Segment	Coal (Loads & Empties)	General Freight	Coal (Loads & Empties)	General Freight
Edgemont S. D. to Donkey Cr.	14	8	33	9
Donkey Cr. to Campbell	5	6	19	7
Campbell to Gillette	4	6	9	7
Gillette to Dutch	4	6	9	7
Dutch to Sheridan	3	6	8	7
Sheridan to Kleenburn	3	8	8	9
Kleenburn to Huntley, MT	2	6	8	7
Huntley to Sarpy Jct.	3	6	7	7
Sarpy Jct. To Nichols	6	6	11	7
Nichols to Forsyth	10	6	17	7
Huntley to Billings	/	14	1	16
Billings to Laurel	0	14	1	16

*Does not include switching movements

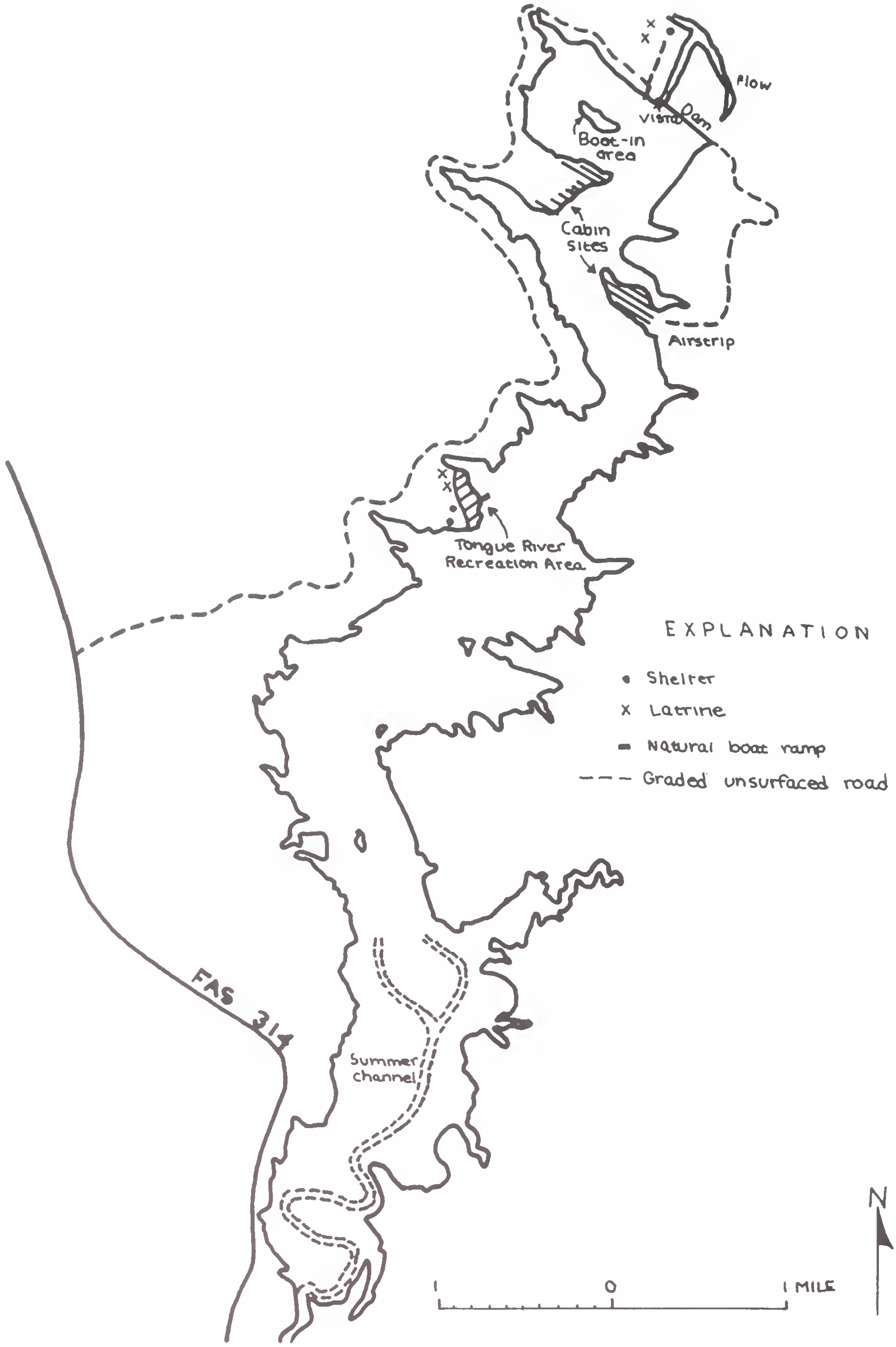

FIGURE II-23.--Map of Tongue River Reservoir showing existing recreational facilities.

3. OTHER TRANSPORTATION

Airline service is provided at Sheridan by Western Airlines. Major connections can be made at Billings, Casper, and Denver. Two private companies provide charter and air-ambulance services from Sheridan.

The Wyoming Public Service Commission has authorized Wyoming Airline Inc. to begin commuter air service between Sheridan, Casper, Gillette, and Cheyenne effective May 1, 1978.

Bus service is available at Sheridan through one company. A taxi service also operates.

The Spring Creek area has no public transportation, nor does Spring Creek or Decker Coal Companies plan any mass transportation for their workers. The mine site is now reached by a private dirt road up Spring Creek from FAS 314. An access road is planned, entering the permit area from the northeast (figures I-9, I-10).

M. RECREATION

Due to the rural nature of the Spring Creek area, recreational facilities and use are oriented toward outdoor-type activities. There are no developed recreation facilities in the proposed mine area and because most of the land is privately owned, the opportunities for general public use are limited.

1. OUTDOOR RECREATION

Recreational use is concentrated at the Tongue River Reservoir, four miles east of the permit area, where opportunitites are provided for camping, picnicking, boating, fishing, water skiing and water-fowl hunting. Existing recreational facilities are generally in poor condition but include latrines and shelters, two natural boat ramps, a vista area, and two semi-developed camping sites (fig. II-23). Grills and garbage cans are located intermittently along the reservoir.

Considerable recreation potential for fishing, hunting, and floating exists along the Tongue River, both upstream and downstream from the reservoir. Recreational use of the river, however, is limited by lack of designated access points (Montana Fish & Game Commission, 1974).

Hunting for big game and upland game birds is the major land-based recreational activity in the area. Several other activities, such as off-road vehicle use (ORV), hiking and cross country skiing are also included in this area to a lesser degree.

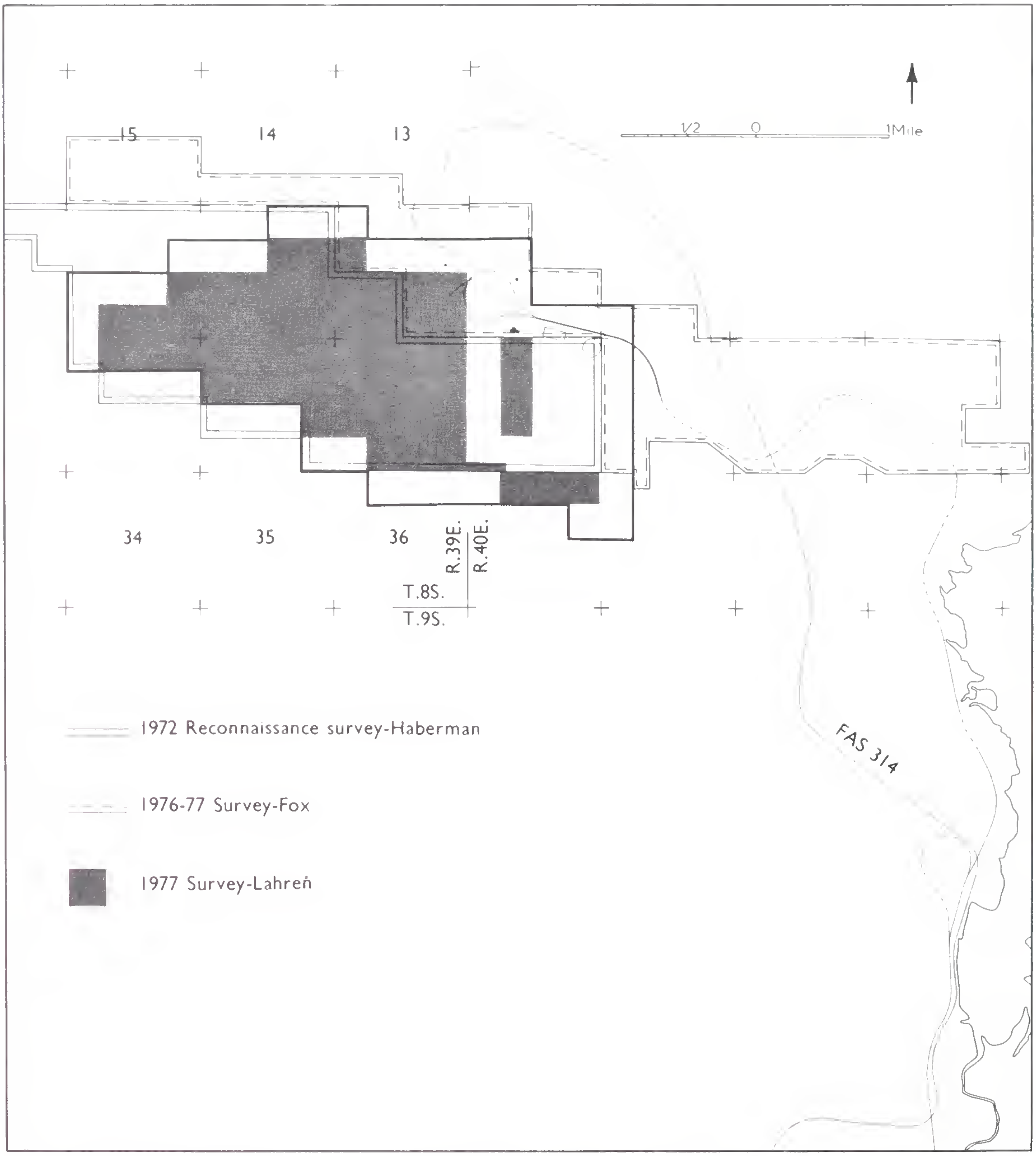

FIGURE II-24.--Cultural resource survey areas

The Custer and Bighorn National Forests are the major public lands available in the area, providing a variety of outdoor recreation opportunities. Although public use in the Custer National Forest has declined over the past five years, use of the Big Horn National Forest has steadily increased; however, the majority of that use is believed to come from the Billings and Casper areas (U.S.F.S., 1977).

2. URBAN RECREATION

Recreational facilities are offered at Sheridan, Wyoming 28 miles south of the mine area. These include a swimming pool, tennis courts, golf course, gymnasium, ice-skating rinks, parks, playgrounds, ball fields, zoo, Y.M.C.A., civic center, tourist attractions, and historic sites. Most community parks and ball fields are only partially developed, many offer no facilities and all are poorly maintained (Meadowlark, January 1978). Only one developed playground now exists.

Due to the influx in population, the demand for recreational services and facilities is increasing. Recreational preferences within the community are changing as the average age of the population becomes lower. The need for improved recreational facilities exist at the present time and future needs are inadequately defined.

Numerous tourist attractions historic sites are located in Sheridan and the surrounding areas.

Actual use figures for most recreation facilities are not available. Generally both outdoor and urban facilities appear to be well used at present, with little or no room for expanded use.

N. CULTURAL RESOURCES

1. ARCHEOLOGY

Cultural resources are fragile and non-renewable remains of human activity, occupation, and endeavor.

Until the recent interest in mineral development few cultural resource investigations had been conducted in southeastern Montana. The area of the proposed Spring Creek mine was surveyed by Haberman (1973), Taylor (1977), and Anthro Research, Inc. (1977) (fig. II-24). A general summary of the indentified cultural resource sites and their types is presented in table II-32.

No sites currently listed on the National Register of Historic Places or the Montana Historic Sites Compendium are in the area of the proposed mine. Sixteen sites in the area of the proposed mine have been determined to be eligible for inclusion on the National Register of Historic Places, a summary of these is presented in table II-33.

TABLE II-32.--Summary of identified cultural resource sites in the area of the proposed Spring Creek mine

Site Type	Haberman (1973)	Taylor (1977)	Anthro Research, Inc. (1977)
Prehistoric			
Lithic Scatter	1	6	39
Chipping Station	1	9	5
Quarry Site	1	2	-
Rock Shelter	-	1	-
Occupation Site	2	13	4
Petroglyph Site	1	-	4
Medicine Wheel	-	1	-
Tipi Ring	-	-	1
Historic			
Homestead	-	3	-
Total	6	34	53

TABLE II-33.--Summary of cultural resource sites determined to be eligible for the National Register of Historic Places

Montana Site Number	Site Type
24 BH 1045	Lithic Scatter
24 BH 1046	Petroglyph Site
24 BH 1052	Chipping Station
24 BH 1583	Lithic Scatter
24 BH 1589	Quarry Site
24 BH 1591	Occupation Site
24 BH 1593	Occupation Site
24 BH 1595	Occupation Site
24 BH 1597	Quarry Site
24 BH 1602	Occupation Site
24 BH 1606	Lithic Scatter
24 BH 1609	Quarry Site
24 BH 1610	Occupation Site
24 BH 1614	Occupation Site
24 BH 1618	Occupation Site
24 BH 1619	Chipping Station

2. HISTORICAL OVERVIEW

a. Big Horn and Sheridan Counties

Sheridan County and the City of Sheridan have had a tradition of coal mining. This mining occurred from the 1890's to 1953 and was basically deep shaft mining. The last deep mine was the mine at Monarch, Wyoming. Most of this coal was utilized for rail use and home consumption. Sheridan County experienced a major economic boom attributable to coal production and homesteading between 1890 and 1910.

The area has been predominantly agriculturally based with ranching and grazing operations. During the 1940's, 1950's, and 1960's, economic stagnation occurred in the area. In the 1970's, strip mining, oil exploration activity, and general economic growth have brought increasing material growth to the area. A large mine just over the Montana line at Decker was opened in 1972 which contributed to this boom. The city of Sheridan has been the regional marketing center for the area, and the city of Sheridan has grown from the most current activities related to fossil fuel.

Big Horn County, Montana, has also been an agriculturally based economy since its inception as a county in 1913. No booms occurred in this county, and prior to 1970 and with the exception of the county seat of Hardin, the area has remained essentially rural. With the advent of new mining in Big Horn County, most of the impacts have been felt in Sheridan County and the city of Sheridan from the spillover effects from the Montana mines.

1. Crow Indians

The Crow Indians (Absaroka) were the first of the Plains Indians to move in the general vicinity of the Missouri and Yellowstone Basin. This occurred in the 17th Century and was made up of about four hundred people. The Crow Indians were historically an agriculturally based tribe; however, when they settled in the Missouri and Yellowstone River Basin, they became nomadic hunters, relying upon the buffalo for their livelihood. By the mid-1700's, the Crow Tribe had established itself as the rightful owner of an area bounded by the Powder River on the east, the Wind River Mountains on the south, the Rocky Mountains on the west, and the Missouri River to the north.

The first treaty signed with the U.S. Government was in 1825, and in 1851 the Crows signed the Treaty of Fort Laramie, which entitled them to 38,883,174 acres in Montana and Wyoming as a hunting reservation. In 1868 the Federal Government reduced the original reservation area to 9 million acres, of which the majority lies in what is now known as Big Horn County, Montana.

In 1884, the Crow Agency was established to help the Crows

create an economy based on agriculture. During the 1880's and 1890's, the Crows sold much of the better agricultural land to non-Indians to pay for their own water irrigation projects. Reservation land area was further reduced to 1,569,288 acres since the early treaties. In 1904 the "ceded area" was formed by the sale to non-Indian settlers of approximately 1.1 million acres of land that had been previously part of the Reservation, north of the present Reservation boundary. In 1958, all vacant and undisposed ceded land was restored by Congress to the Crow Tribe, along with the mineral rights to the coal resource in an area of about 150,000 acres.

Today the Crow Tribe consists of approximately 5,500 tribal members living on or near the reservation. Most of those members who are living on the reservation are concentrated along Interstate 90 and the Little Big Horn Valley.

Within the boundaries of the Crow Reservation, substantial sub-bituminous coal deposits exist. Some of these deposits have been leased to private coal companies. Peabody, Shell, and Gulf have leased coal on the reservation and ceded area; Westmoreland Coal Company and Amax hold leases on the "ceded land". No production has yet occurred with the exception of Westmoreland III on the ceded lands just north of the Crow Reservation.

2. Northern Cheyenne Indians

The Northern Cheyenne Indians came to the plains area in the 17th century as a result of pressures from American and Canadian westward expansion. They were nomadic Indians using houses, and hunted for their livelihood. Prior to then, they had been basically agricultural people. After the Civil War, the Cheyenne peoples came into direct conflict with the white man over hunting territories. This dispute culminated in 1876 with the Battle of the Little Big Horn.

The Northern Cheyenne Indians participated in the Friendship Treaty (1825), the Ft. Laramie Treaty (1851), and the Treaty of 1868, which granted a large hunting domain for them. In 1884, the Tongue River Reservation was established. It consisted of 371,200 acres in southeastern Montana. Later the name was changed to the Northern Cheyenne Indian Reservation.

In 1934, under the Wheeler-Howard Act, the Northern Cheyenne Indians were granted authority to establish a democratic tribal council with a president and five voting districts.

As of 1974, there were 444,308 acres of land within the reservation. More than half of the land was purchased by the Northern Cheyenne tribe.

The Northern Cheyenne Reservation is underlain by large

deposits of coal amounting to an estimated 5.2 billion tons. Since the mid 1960's, much controversy has existed over the control of this coal. In 1976, the U.S. Supreme Court settled the conflict by ruling that the Cheyennes had complete mineral rights on the reservation. Furthermore, the Northern Cheyenne Reservation currently has been designated as a Federal Class I air quality region, which means that certain types of air pollution are prohibited on the reservation.

O. ESTHETICS

The proposed mine area can be described as a quiet and peaceful tract of grazing land with average scenic values (Class C-8 based on the Visual Resource Management System of the Bureau of Land Management, appendix E). Evidence of manipulation by man is limited. The area varies topographically from stream valleys to gently rolling hills, rocky canyon walls, and sandstone buttes. There is a moderate variety of color, including scattered patches of dark green pine trees, red clinker, and tan sandstone. Vegetation produces variations in patterns and textures. The predominant odors in the area are those of the vegetation. Noises in the area are those from distant mining equipment at the Decker mine, vehicles and farm equipment, livestock, wildlife, and wind.

CHAPTER III: PROBABLE IMPACT OF THE PROPOSED ACTION

A. GEOLOGY

The most important geological impact from implementation of the mine plan would be increased erosion and deposition in the permit area. Because the mine plan does not include adequate mitigating measures, the reclaimed land surface would be subject to long-term instability, thereby limiting reclamation and future land use (See Land Use III). Destruction of the stratigraphic sequence would also affect ground water, soils, and vegetation.

The 243 million tons of coal removed would be irretrievably committed to the beneficial use of the resource, but would be lost from future use. This would not interfere with future development of other mineral resources in the area.

1. TOPOGRAPHY AND GEOMORPHOLOGY

The primary adverse impact on topography and geomorphology from mining would be a decrease in stability of the disturbed land surface. This instability would increase the geologic processes of erosion in some places and deposition in others, primarily within the permit area; hence, reclamation and revegetation would be hindered. The instability of the land surface would locally impact soils and vegetation, and, to some degree, would limit future land use (see appropriate sections).

During mining, erosion would be accelerated by an unknown amount as a result of both the surface disruption by men and mining machinery and by the construction of the proposed diversion channels. Also, an unknown amount of hillslope sediment movement would occur as the slopes reestablish an equilibrium with the steeper diversion-channel gradient.

The ridge between the two forks of Spring Creek would be eliminated because there would be insufficient spoil material to return the land surface to the approximate original contour and, at the same time, maintain stream gradients (fig. I-20). The ridge would be replaced by a broad, gentle, southeasterly-sloping plane about three miles long.

This plane would be susceptible to wind erosion unless vegetation is quickly reestablished. Local irregularities may be expected to occur on the reclaimed surface, because of variations in initial grading and differential spoil subsidence. To the extent that depressions may form, surface water and sediment would collect in these depressions and would, therefore, not reach the major stream channels.

Either of two adverse impacts could result from water collecting in local depressions, depending on whether the water infiltrates or the depressions seal and the water evaporates (Lusby and Toy, 1976). Infiltration would increase spoil subsidence, whereas evaporation would

tend to concentrate salts on the surface. The presence of excessive salts would be adverse to plant growth.

Severe rill and gully erosion would occur on highwalls regraded to the proposed 3-to-1 slopes (about 20 degrees). These slopes would be up to 200 feet high and would range in length up to approximately 600 feet: erosion control in the semiarid West has not been proven on slopes of such length and gradient. The particulate nature of topsoil used in reclamation would likewise not be conducive to stability on long, straight, steep slopes.

The regraded highwalls would intercept the drainages of the ephemeral tributaries to Spring Creek and South Fork, thus initiating headward erosion at these points. This would result in severe erosion above the highwall slopes and deposition of sediments on the sloping plane below them. Erosive processes likely to be active above the highwall would be rill and gully formation, as well as deepening of the tributary channels. Approximately 700 acres south of South Fork would be affected.

Mining would create a topographic surface in disequilibrium with the surrounding landscape. The long-term result of this disequilibrium would be accelerated erosion throughout both the mine area and the Spring Creek drainage. Studies of activities similar to mining, indicate that sediment yield to the mine area would increase about fivefold over present rates (Gregory and Walling, 1973). Postmining erosion may decrease in time as equilibrium is regained and as revegetation takes place; however, this cannot be predicted with reliable accuracy.

2. OVERBURDEN

Mining would destroy the natural overburden stratigraphy which would have impacts on soils, vegetation, and ground-water (these impacts are discussed in their respective sections).

3. PALEONTOLOGY

Impacts to paleontological resources would consist of losses of plant, invertebrate, and vertebrate fossil materials for scientific research, public education (interpretative programs), and to other values. Losses would result from destruction, disturbance or removal of fossil materials as a result of coal mining activities, unauthorized collection, and vandalism.

A beneficial impact of development would be the exposure of fossil materials for scientific examination and collection which otherwise may never occur except as a result of overburden clearance, exposure of rock strata, and mineral excavation.

All exposed fossiliferous formations within the region could also be affected by increased unaurthorized fossil collecting and vandalism

as a result of increased regional population. The extent of this impact cannot be presently assessed due to a general lack of specific data on such activities.

B. HYDROLOGY

The loss of the surface water (one perennial spring on the South Fork and several ephemeral impoundments on the permit area) would limit future use by livestock and wildlife. The company's proposed mitigating measures are not adequate in that the five water impoundments would fill with sediments in about 10 years, thus making them useless without further maintenance. Proposed stream diversions may be subject to erosion. The company does not propose to construct sediment retention facilities on these diversions and therefore, to the extent sediment may be eroded, some sediment may leave the permit area. Although the company proposes to comply with state and federal regulations, off-site sedimentation would be in violation of these regulations. Post-mining runoff from the permit area would be reduced by a small amount, as would sediment yield; at the same time erosion would increase an unknown amount within the permit area, mainly on the valley walls and at steepened points of the regraded highwalls (see Geomorphology III).

The loss of the ground-water supply (the alluvial and Anderson Dietz aquifers, the sources for the spring and several wells) would have an adverse impact on the future use by livestock and wildlife. The destruction of the alluvial aquifer would be particularly important because it is the source of the only perennial surface water on the permit area; its loss would additionally preclude successful reestablishment of present vegetation (see Vegetation). However, the impact to livestock would decrease in significance because, although the proposed plan does not contain the appropriate measures, the impact can be mitigated by obtaining water from deeper aquifers. The impact to wildlife and vegetation, which are dependent on water from the alluvial aquifer, on the other hand, would be significant because it cannot be mitigated. The quality of ground-water in the Anderson Dietz aquifer east of the permit area may be degraded because of the leaching of spoils and may become, thereby, unacceptable for usage.

1. SURFACE WATER

Mining would destroy the spring issuing from the alluvium along South Fork Spring Creek, which is the only perennial surface water resource on the permit area; destriction of the spring would preclude livestock and wildlife use of it, hence diminishing the value of the area for post-mining use. Seven stock ponds would be destroyed and then replaced with five new impoundments having a combined total capacity of about 100 acre-feet, far surpassing the capacity of the existing ponds. The proposed impoundments in the permanently relocated channels would function as traps for sediment derived upstream from the permit area

during flow events and would fill with sediment rather quickly, thereby losing their effectiveness. The rate of infilling would vary greatly with the intensity of runoff events. And, if head-cutting should occur, the life of the structures would be reduced to, perhaps, a few years.

Given the pre-mining sediment yield from the South Fork drainage of about 6.5 acre-feet annually, the three ponds on South Fork would, beginning with the upstream pond, theoretically fill up in about 10 years. It is assumed that the two ponds on Spring Creek would fill at a similar rate.

The temporary diversion channels are not designed for flood flows of a 40-year frequency, and may become sources of sediment that discharge from the permit area. The probability of a 50-year event or larger occurring at least once during the life of the mine is 40 percent. During the life of the mine, the two stream diversions would normally carry a little less water than before mining, because of the loss of contribution from the mine area, but the decrease would be negligible.

During mining sediment generated along the diverted reaches of Spring Creek and South Fork may increase slightly for runoff events of less magnitude than a 10-year frequency. The diversions would be constructed on hillsides to allow mining of the stream bottoms; thus an increase in sediment yield would be expected. Under the proposed gradients and channel design, sediment yield may increase gradually to significant amounts for 10-year frequency and greater floods. A 50-year peak flow would probably erode the 1-foot clinker lining proposed for the diversion channels. Velocities would be especially high in the lower reaches of the diversion channels where the gradients steepen. Head cuts could form at the points where the slopes increase. Because no sediment retention facilities are planned on the diversion channels, sediment eroded from these channels would leave the permit area.

Erosion could widen the channels. If the channel were to be widened two feet, Spring Creek with 10,800 feet of diversion channel would yield about 8 acre-feet of sediment, and South Fork with 22,600 feet of channel would yield about 17 acre-feet of sediment. Greater scouring would, of course, cause progressively more sediment yield from the banks, and perhaps, a significant amount from the channel bed. Because of increased evaporation and infiltration from the post-mining surface, the annual runoff from the permit area would be decreased. If all the runoff from the mine area were to be lost, the loss to the Spring Creek system would be less than 10 percent; therefore, this impact would not be significant.

After mining and reclamation, the amount of sediment leaving the permit area would remain the same as during mining, and may decrease somewhat compared to premining or natural conditions. Because the reclamation would leave a flat area with a 1-percent slope west to east, the sediment yield from the area should be less. The accumulation of sediment from erosion of the reclaimed highwalls would not reach the reconstructed stream channels.

Quality of surface runoff from the reclaimed area would be little changed from premining conditions, except during periods of abnormally high peak flows, when the quality of the water would likely be degraded by an unknown but insignificant amount.

Neither the railroad spur nor the access road to the mine would likely yield significant amounts of sediment; both would be metaled with clinker, which is highly permeable and coarse enough to resist significant erosion. Moreover, sediment from the access road would be trapped in borrow pits at the base of side slopes. Depending upon the intensity of runoff events, minor amounts of sediment may reach the Tongue River Reservoir from railroad crossings on Pearson and Spring Creeks. However, sediment from this source should have an insignificant impact on surface water quality.

2. GROUND WATER

The physical removal of the alluvium of South Fork and the Anderson-Dietz from beneath the permit area would have little impact on ground water because mitigating measures are feasible. Destruction of the alluvium would create the greatest impact because it is a source of spring water used by livestock and wildlife. The destruction of the alluvial aquifer along South Fork Spring Creek would also preclude reestablishment of vegetation similar to that now growing along this stream (see Vegetation III).

No significant impacts to the alluvial aquifer west of the permit area are foreseen, although the one perennial pond on South Fork immediately west of the area might drain because of disruption related to mining activities.

A source of well water within the mine area would be lost through removal of the Anderson-Dietz aquifer. In turn, removal of the aquifer would adversely affect two existing wells adjacent to the permit area. The water level in a well in the NE1/4 NE1/4 of section 31 would probably drop to near the bottom of the well, and the unused well in the westcentral part of section 24 would probably become dry. The well in the NW1/4 NW1/4 corner of section 24 is deeper than the well identified above and should not be seriously affected.

The quality of ground water likely would be degraded in the Anderson-Dietz aquifer east of the permit area because magnesium sulfate leached from the spoils would migrate into the undisturbed, downdip coal and clinker horizons adjacent to the mined aquifer. The water moving to the east would be diluted by local recharge; hence the suitability of that mixed water for use by livestock is uncertain. Water samples from wells drilled in the spoils at the nearby Decker mine contain about 4,300 milligrams per liter of dissolved solids; this water may not be

suitable for either domestic or livestock use.

At present no wells in the area east of the mine would be likely to survive the lowering of the water table resulting from the Spring Creek and the Decker North extension mines; therefore, decreased water quality would not be significant to local water use.

Leaching of Spring Creek mine spoils is not expected to add a significant amount of dissolved solids (less than 0.1 percent) to the Tongue River. Contributions of dissolved solids from other concurrent mining in the region are estimated to add about 0.3 percent to the dissolved solid load of the Tongue River.

C. CLIMATE

The impacts of the proposed mine on the microclimate are estimated to be localized and quantitatively unknown. However, assuming reclamation is successful, we anticipate slight changes in humidity, temperature, and wind patterns resulting from changes in topography and vegetation.

D. AIR QUALITY

The extraction of 243 million tons of coal from the Spring Creek Mine would degrade the air quality of the area. This primary or direct impact to the airshed would then effect changes in biological systems, termed secondary impacts.

Primarily, the airshed would be subjected to large quantities of particulates (fugitive dust) and, to a lesser extent, emissions of the pollutant gases sulfur dioxide, nitrous oxides and carbon monoxide. These emissions would continue for a minimum of 25 years, the period of active mining.

Secondary impacts include: (1) deposition of particulates in areas of high vegetative productivity, (2) minor changes in plant community productivity and composition, (3) potential trace element toxicity to insects, (4) detectable increases in respiratory disease in domestic animals, and (5) possible respiratory disease in mine personnel.

The mining processes associated with these increased pollutant emissions are:

1. topsoil: removal, transport, and storage;
2. overburden: blasting, removal, deposition, and storage;
3. coal: blasting, extraction, and transport to storage area;
4. coal processing:
5. transport of the coal via unit train to utilization site;
6. reclamation: replacement of overburden, topsoil, and revegetation;
7. vehicular traffic in and around the mine area;
8. increased population.

The major pollutant would be particulates (fugitive dust) composed of topsoil, overburden, and coal dust. The theoretical maximum annual fugitive dust emissions would be 21,200 tons per year. This is assuming to atmospheric emission controls. For comparison, the total annual particulate emissions from Colstrip units 1 and 2 at full generation capacity is predicted to be 1,613 tons per year (Montana DHES, 1974).

1. PRIMARY IMPACTS

Beginning in the third year of operation, 10 million tons of coal will be extracted annually from the Spring Creek mine. The West Decker mine, about 5 miles southeast is presently producing an equivalent tonnage.

Based upon observations at Decker, the annual baseline TSP concentration at Spring Creek would increase by a factor of 3.5 near major traffic routes and coal handling facilities. This would violate Federal secondary standards and approach violation of Federal primary and Montana State Guidelines.

The maximum allowable Montana Guidelines and Federal primary standards for 24 hour TSP concentration would also be exceeded several times annually.

With a potential increase of particulate emissions of 21,000 tons annually there would be a substantial increase in dustfall in the area with possible violations of Montana State guidelines. This trend is evident at Colstrip, Montana.

Since the dominant winds are from the northwest (see Climate II) particulate from the Spring Creek mine can also be expected to contribute to a decrease in visibility and aesthetics in the Tongue River Reservoir-Decker area. The Northern Cheyenne Indian Reservation would not be affected.

The emission of gaseous pollutants from the mining operation would have a lesser impact on air quality. Generally, there would be no violations of the air quality standards. However, NO_x fumes from blasting episodes and coal bank fires (gaseous emissions from these fires are similar to those from coal fired power plants) could create a temporary but significant decrease in visibility. In conjunction with increased atmospheric pollution acute fumigations of this type may harm living organism downwind of the leashold.

The air quality of the region will also be impacted by two other activities: (1) the transport of the coal via unit train and (2) the increase in population due to coal development. Not only will the unit trains emit gaseous and particulate pollutants from the diesel engines; there would also be a significant (2 percent) loss of coal in the form of dust from the open coal cars (URS, 1976).

The annual coal dust emission along the railroad corridor would be approximately 200,000 tons. The distance this dust would travel and its impacts are unknown.

On a regional scale, air quality impacts from population influx associated with the Spring Creek Mine, may equal or even exceed the impact due to the proposed mining operation. Temporarily, a construction camp housing 220 employees will cause increased vehicle traffic on dirt roads, and create exposed, bare areas for a trailer court. The Spring Creek Mine would permanently employ 253 people, with an ancillary population of 734 persons in the Sheridan area (see socioeconomic impacts). The particulate and gaseous emissions associated with roughly 1000 people is shown in table III-1.

2. BIOLOGICAL AIR QUALITY IMPACTS

a. Wildlife and Domestic Animals

Long-term ingestion of dust particles containing arsenic, berylluim, fluoride, lead and zinc may adversely affect bacteria responsible for cellulose digestion in the cow's stomach. These elements may also accumulate in the bones and body tissues. Increased ingestion of molybdenum (either accumulated in or on the vegetation) could cause molybdenosis in cattle (Erdman et al, 1978). Dust particles on vegetation may also wear down the teeth of foraging animals.

The increased dust on soil and vegetation may disturb respiratory functions in cattle due to inhalation deposition and retention of the particulate in the gas exchange regions (alveoli) of the lungs (USDA Handbook No. 380) and may lead to increased incidence of respiratory disorders (DHES, Public Hearing, March 11, 1978).

b. Terrestrial Insects

Trace elements tend to accumulate in insects, especially at the higher trophic levels. Many of these elements are toxic at low concentrations, depending on insect size, species, mobility, and feeding or behavioral patterns. Honeybees may be the most susceptible of animals to fluoride, arsenic, lead, copper, zinc, phosphorous, mercury, cobalt, and cyanide. It is believed that honeybees and other pollinators may accumulate these elements from pollen. This makes honeybees very susceptible targets for trace element toxicity even when these elements are found at very low levels in vegetation and soils (Bromenshenk, 1978).

Soil inhabiting insects may also be poisoned by trace element deposition on the soil surfaces (Bromenshenk 1978).

c. Human Effects

Dust generated by mining operations at Spring Creek could also be expected to effect human health. Those workers at Spring Creek

TABLE III-1.--Estimated uncontrolled atmospheric emissions at the Spring Creek mine based on a coal production of 10^6 tons/year

[Values are in tons per year]

Source	Particulate	SO_2	NO_x	Co	HC	HCN	Aldehydes	Organic Acids
1. Mining (all Operations)	21122	---	---	--	--	---	---	---
2. Population increase	60	70	170	340	130	---	---	---
3. Internal combustion engines								
A. Vehicles	28	30	409	144	105	---	---	---
B. Coal trains	16	36	237	84	60	---	3.7	4.2
4. ANFO explosives	unknown	---	6	68	---	0.2	---	---
TOTAL	21226	136	822	636	295	0.2	3.7	4.2

exposed to high dust concentrations may suffer some or all of the following diseases: coal miner's pneumoconiosis, silicosis, or industrial bronchitis, alone or in combination (Bergen, Appendix D-4). These diseases are correlated to high carbon content of the coal dust, and to extremely small particle size.

If new towns are built in the area of Spring Creek mine, there may also be dust impacts on community residents, especially chronic bronchitus.

E. SOILS

1. RECLAMATION

If the Spring Creek permit area is mined, the soils, and the ecosystems based on them would be destroyed. After reclamation, if successful, ecosystems in the permit areas would be less stable, and less diverse, causing long-term impacts on both quantity and quality of vegetative production. This would also impact animal populations dependent on diverse plant communities.

Successful reclamation would be unlikely under the proposed mining and reclamation plan, for the following reasons:

Soil Salinity: the Company proposes to salvage "topsoil" material to an Electrical Conductivity (EC) value of 8.5 mmhos/cm (State guidelines suggest limiting EC values to 46 mmhos/cm). Such high soluble salt contents have been demonstrated to cause dramatically reduced germination and yield rates (over 50 percent) in forage species even under otherwise ideal conditions (Richards, 1954). Germination rates and seedling survival are more severely impacted by soil salinity than are the yields of established plant communities. Therefore, high salinity levels which are tolerable in native range would be extremely deterimental to reclamation efforts in the same region. This situation has been demonstrated in Montana (Neil Harrington, Dept. of State Lands, personal communication).

Sodic Overburden: the Company makes no provision to effectively bury the highly sodic overburden material which dominates the permit area, especially in the eastern and central portions. Sodic overburden has been demonstrated to contaminate 12 inches of non-sodic "topsoil" material by upward migration of sodium over a period of 3-5 years (Agricultural Research Service and North Dakota Agricultural Experiment Station Staff, 1977). Excess sodium causes dispersion of soil particles, leading to structural instability, reduced infiltration and permeability, increased susceptibility to water erosion, and surface crusting. For vegetation, this means increased mechanical resistance for seedling emergence and root elongation, and reduced water availability. The net result is increased mortality. The combination of saline and sodic conditions serves to compound the problem and the likelihood of reclamation failure.

In assessing the probable success of reclamation at any given site, it is essential to consider experience at existing mines in terms of the prevailing physical and chemical conditions at the respective sites. For example, naturally revegetated abondoned mine spoils at Colstrip dating back over 50 years are frequently cited as evidence that reclamation is relatively simple and effective in the region. Unfortunately, such results cannot be transferred to Spring Creek because of significant differences in soils, overburden and climatic characteristics. Likewise, results at West Decker, where conditions are similar, reflect a maximum of three growing seasons, and cannot be assessed for success over a longer period, despite the relatively intense management applied at that site.

2. SITE SPECIFIC PROBLEMS

The specific characteristics of soil and overburden at Spring Creek include the following:

- The extensive, deep Colbar and Kimlen soil series which would provide the bulk of "topsoil" salvage are excessively saline (over 6 mmhos/cm) below a mean depth of 32 inches.

- Should the Company proceed with the salvage of saline soil materials, much (up to 50 percent) of the post-mining surface would be saline, with the results discussed above (soil salinity).

- If the applicant is prohibited from salvaging these saline soils, the average depth of "topsoil" material would be reduced 50 percent, from 26 to 13 inches.

- The overburden located in the eastern half of permit area has an average Sodium Adsorption Ratio (SAR) of 29.6, while the western half averages 16.6 (State guidelines cite a limit of 12 for reclamation materials).

- The Company prefers to cite and use the lower Exchangeable Sodium Percentage (ESP) values, which average 14.6 percent for the entire permit area, and range upwards to 47 percent.

- The State of Montana has not issued guideline values for ESP, but the literature does provide a limit of 12 percent as a division between sodic and non-sodic soils (Richards, 1954).

- Published levels affecting soil development are lower, ranging from 7.5 to 5 percent (Russell, 1961; Dregne, 1976; Omodt, et. al, 1975).

- The ESP value of 5 is cited by Omodt, et. al. as capable of causing dispersion in material placed on the surface of mined land.

- Should the Company be permitted to place overburden spoils without regard to sodium status, high percentage of the mined area would become sodic over a period of time ranging up to 10 years.

- A combination of saline and sodic spoils would render reclamation efforts ineffective.

In addition to sodium and salinity problems, the Company's mine plan does not address the long term (post bonding period) implications of a potential molybdenum-induced copper deficiency disease (molybdenosis) induced by high molybdenum levels and (or) low copper:molybdenum ratios. This condition could lead to weight loss and possibly death of cattle grazing primarily in reclaimed areas (Erdman et. al., 1978). The applicant's consultant suggests various procedures which would treat the problem, but not solve it.

3. GENERAL MINING IMPACTS

A number of chemical and physical impacts that would occur at any surface mining site in the semi-arid west would constitute a long-term commitment of soils and related plant and animal resources. The effects of these impacts include:

- A short-term (2-3 years) release of nutrients, followed by a net reduction in plant available nutrients, phosphorus and nitrogen in particular.

- Soil microorganisms populations are disrupted, as are soil microclimates, resulting in drastically reduced decomposition rates of dead plant material. Nutrients are not released, and the cycle is incomplete

- Typically, these conditions result in dramatic decreases (to 75 percent) in vegetative productivity about 5 years after the start of reclamation procedures.

- Reductions in infiltration rates as a result of loss of soil structure, particle dispersion, increased bulk density and surface crusting.

- Reduced plant available water, as a result of reduced infiltration rates and loss of structure.

- Reduced soil diversity in chemical, physical and topographic aspects

- Long term instability, due to very slow rates of soil development and topographic uniformity.

These impacts constitute a basic level sacrifice of range and agricultural resources for the foreseeable future.

Specifically, this entails a 2-to5-fold or greater increase in erosion rates (Lusby and Toy, 1976), decreased plant community diversity, productivity and composition based on soil characteristics and diversity. This directly affects quality of livestock forage throughout the year (See Vegetation, Chapter III) and wildlife habitat (See Wildlife, Chapter III). In addition, decreased soil/ecosystem stability magnifies the impacts of detrimental characteristics of "topsoil" and overburden spoil materials beyond the influence which would be the case for undisturbed range.

4. POST-MINING MANAGEMENT

During the course of mining, a lot should be learned about what can and must be done to effect successful reclamation. If the Spring Creek permit area is mined, by the time the final acreage is released from bond, the Companyhave 35 or more years experience. Assuming that the Company would be induced to modify the mining and reclamation plan to avoid the problems of saline and sodic materials prior to mining, the short and medium term reclamation could be successful. But, in the long-term, much is left to chance.

Soil development is slow in the semi-arid region in which Spring Creek is located, where soils are classified as poorly developed Entisols even after several thousands of years. The more fully developed Aridisols and Mollisols may date back to the late Pleistocene, and have been influenced by a range of climatic regimes, some wetter and cooler than those experienced in the more recent past.

Slow rates of development indicate long-term instability of reclaimed mine spoils. It is possible, even likely, that the Spring Creek area, among others, would be subject to some form of mismanagement through grazing, agricultural, recreation or development during this extended period of instability. Disturbance or compaction could easily accelerate erosional processes, reverse plant succession and culminate in areas of very low productivity.

F. VEGETATION

The most serious impact on vegetation would be the long-term elimination of the vegetation mosaic and species diversity and a reduced potential productivity for several decades. Loss of diversity and reduced productivity would be due to the permanent alteration of the requisite edaphic, topographic, geologic, hydrologic, and microclimatic conditions for the maintenance of the vegetation. This would seriously reduce the capability of the reclaimed vegetation to provide suitable wildlife habitat, watershed cover, livestock forage, and would reduce the esthetic value of the area (see appropriate sections). Mining reclamation must comply with Federal and State regulations; however, compliance alone does not insure success. The company's mine plan does not address the long term (post bonding period) implications of a potential molybdenum-induced copper deficiency disease which could occur when plants (particularly legumes favored in reclamation seed mixes) root in overburden materials.

For the first several years after reseeding, (table I-3), reclaimed areas would have a relatively uniform cover of grasses, forbs, legumes, and weedy species. Existing seed in the reclaimed topsoil would contribute only slightly to the new vegetation since most of the viable seed would be killed by stockpiling and/or too deep burial during redistribution of the topsoils. Invading annual weeds would be relatively dense the first few years, then would decline sharply as perennial species crowd them out. Possibly within a decade, reseeded areas would have developed a self sustaining, adequate ground cover. In the event of severe drought, density and abundance of species would probably diminish markedly, and would have to be reseeded (prior to the release of the reclamation bond) to comply with State and Federal regulations. Erosion of redistributed topsoil along graded highwalls (about 145 acres total) and burial of plants by deposition along the base of reclaimed highwalls, would also necessitate occassional reseeding.

A decade or two after reseeding, heterogeneous vegetation patterns would possibly begin to appear in the heretofore uniform vegetation. Such patterns would likely develop along the mine boundaries, by encroachment of vegetation from adjacent undisturbed areas, and in localized microsites within the mine area. A wave of plant succession would gradually continue across the reclaimed area. By the time the mine would be abandoned, therefore, incipient vegetation patterns would possibly be recognizable in the earliest reclaimed areas.

Present technology has failed to demonstrate an ability to reestablish ponderosa pine, Rocky Mountain juniper, deciduous trees, and many shrubs in reclaimed mine areas of the Northern Great Plains. Several plant species would be precluded from reestablishment of the mine area, particularly those which require specialized microenvironments for their maintenance. Ponderosa pine would undoubtedly be lost as a self-sustaining population for the long-term and might be irretrievably eliminated, because the requisite moisture, soil, and bedrock conditions would be irreparably destroyed. Further, the success of establishing this species in areas of marginal moisture has not been demonstrated. Rocky Mountain juniper would also be lost from the reclaimed area for the long-term. This species, however, would be more likely to become reestablished since it is less dependent on those conditions which support ponderosa pine.

Destruction of the discontinuous alluvial aquifer on South Fork would permanently preclude the reestablishment of those deciduous trees which require a perched water table. Other species such as the deciduous shrubs of the riparian community would be lost for the long-term (perhaps several decades), until natural encroachment of these species occurs. Competition with grasses and forbs would delay this encroachment for an unknown period of time.

Reclaimed vegetation and native vegetation in close proximity to the proposed mine and facility locations would be impacted to varying degrees by such disturbances as dust, offroad vehicle travel, and fire.

Most of the impacts would be of short duration and essentially would cease with abandonment of the mine.

Dust, which would tend to settle in areas of reduced wind speed and the more biologically productive areas, would impact vegetation to an unknown degree. The so-called "lower" plants would be the most susceptible; however, the vascular plants would also be impacted. The physical presence of dust on foliar surfaces, regardless of the chemical composition, may interfere with physiological processes of individual plants.[1] The interference with these processes may alter the competitive abilities of some species more than others, causing the elimination of certain species or at least a reduction in their frequency of occurrence. The clay, shale, and coal components of dust, from the Spring Creek area, would contain higher concentrations of manganese, molybdenum, zinc, boron, lead, and nickel than are found in the topsoil. Trace elements in the dust may not cause problems for the plants, per se, but could cause problems for foraging livestock and wildlife. Further, dust would reduce the palatability of vegetation for these animals.

Off-road vehicle travel, in addition to causing dust, would create significant localized soil compaction. This compaction would result in severely reduced vegetation productivity in vehicle tracks; thereby, inducing potential rill and gully erosion (Chapter III. Geomorphology and Recreation). During the mine life, a slight increase in fire frequency would be due to mining related activities; however, most fires would probably be restricted to a few acres because the company would provide fire-fighting equipment at the minesite.

1. RARE AND ENDANGERED SPECIES

There are no known rare or endangered plant species in the area to be affected by the proposed mine.

G. WILDLIFE

Impacts on wildlife arising from the proposed Spring Creek mine would be more severe than any of the other existing or currently proposed coal strip-mining operations in southeastern Montana. These impacts are anticipated because of the destruction of habitat which supports a high diversity of wildlife species and which supports large concentrations of several wintering species. A greatly reduced carrying capacity would result, because of changes in vegetation and topography; therefore, wildlife populations on the entire permit area would be

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[1] Several articles have been written about the detrimental effects of dust on plants. Selected references include: Auclair, 1976; Brandt and Rhodes, 1972, 1973; Eller, 1977; Gilbert, 1976; Kovar, 1977; Manning, 1971; and Shonbeck, 1960.

destroyed or displaced during mining and would not be expected to return to premining levels for a long period of time. Adverse impacts would be of major significance on a site-specific basis, and somewhat less significant considering the larger Decker subregion as a whole. Within the 4,420-acre permit area the topographic relief would be destroyed and the soils and vegetation disturbed to varying degrees (Chapter III. Topography, Vegetation, and Soils). Current mining and reclamation plans cannot restore these aspects of wildlife habitat; hence, impacts to wildlife would be perpetuated.

1. HABITAT

Mining would result in the loss or disturbance of about 4,420 acres, all of which is classified as wildlife habitat (table II-10). The habitats containing the vegetation types such as ponderosa pine, big and silver sagebrush, and other shrubs such as shadscale, saltbush, and skunkbush, would be lost during mining. Reclamation efforts to date have not successfully demonstrated that these habitat types can be reestablished on a self-regenerating or self-sustaining basis.

2. LARGE MAMMALS

a. Antelope

Antelope would be the most severely impacted mammal by the proposed operation, because of a greatly reduced carrying capacity, resulting from the physical loss and impeded utilization of the major antelope use areas (fig. II-12) by mining and associated facilities. The most severe impacts would be on the northern half of the mine area and along the railroad and access road corridors. Blockage of migration routes and disruption of local movement patterns are expected to result in the impeded utilization of otherwise suitable habitat. Seasonally important areas may become inaccessible, thereby potentially eliminating a critical component (wintering or kidding areas) necessary to the life cycle of antelope. The loss of wintering habitat would have adverse impacts on antelope far removed from the mine site.

b. Mule Deer

The proposed Spring Creek mining activities would greatly reduce the carrying capacity of the area and thereby inflict substantial adverse impacts on mule deer which use the area year-round and those which use it seasonally. The entire permit area is classified as mule deer habitat. As with antelope, the loss of wintering habitat would have severe adverse impacts on mule deer populations far removed from the mine site (perhaps as far as 25-30 miles) and to the local population. Impacts to mule deer are expected to be the greatest in the southern half of the mine area with somewhat less severe impacts arising along the railroad corridor and the northern portion of the permit area (See fig. II-13).

Major north-sough and east-west migration routes between major use areas and local movement would be blocked by mining activities and the railroad corridor. Probably the most serious impact of this nature would be the potential isolation of wintering or fawning areas from habitats used during other seasons.

c. White-tailed Deer

Impacts to white-tailed deer would be minimal since these deer utilize the permit area very infrequently.

3. OTHER MAMMALS

Mining would progressively destroy small mammal habitat on the minesite and all ancillary facility areas. Small mammals would be almost totally eliminated from disturbed areas during mining, however, some species populations would probably return to near premining levels after revegetation. Mining would eliminate the ponderosa pine/juniper and sagebrush/grass habitat in which small mammals are currently most abundant, and revegetation would create dominantly grass habitat, in which they are currently least abundant. Thus all existing species would not approach their premining population levels for at least several decades. In addition, mining would eliminate most escape cover (rock crevices and dense stands of shrubs) for cottontail rabbits, hence onsite populations would probably never attain their premining levels. Lowered small mammal abundance would adversely affect many predator species (mammals, birds, reptiles) which depend on small mammals for prey.

4. UPLAND GAME BIRDS

Sage grouse would suffer the most severe adverse impacts of the four species of upland game birds observed on the area. The greatest adverse impact would be the loss of the most important breeding area and critical wintering habitat in the Spring Creek vicinity. The "Upper Divide" breeding site (fig. II-14) accounts for a majority of the known sage grouse production in the Spring Creek vicinity, and its loss would have severe adverse impacts on the surrounding sage grouse population.

The most significant adverse impact on sage grouse occurring from the proposed action would be the loss of critical wintering area within the mining area. This "key sage grouse wintering area" provides the food and cover necessary for sage grouse survival during severe winter months, suggesting that sage grouse migrate to this particular wintering area from areas far removed from the mine site. Consequently, loss of this critical habitat would adversely affect the total sage grouse population in the Spring Creek vicinity.

Sharp-tailed grouse populations would decline due primarily to elimination of about 2,750 acres of winter range in sagebrush/grass habitat, and secondarily to elimination of dance areas, one in the mine area, a second near the railroad loop and possible disturbance of several others near the mine (fig. II-14).

Ring-necked pheasants will probably not be significantly impacted by the proposed action because of their scarcity in the Spring Creek vicinity. Gray partridge may suffer some adverse impacts because of permanent loss of wintering habitat, sagebrush/grass habitats in particular.

5. RAPTORS

About 13 raptor nesting sites would be permanently lost during mining, because ponderosa pine trees and sandstone cliffs, the two most important breeding habitats for raptors in the mine area (Lockert, 1976), would be lost. Long-eared owls, great-horned owls golden eagles, kestrels and red-tailed hawks would thus be displaced to alternative sites and subregional populations lowered. Raptor populations on and near the mine would be further reduced by the reduction in prey.

6. SONG BIRDS

Mining would markedly reduce songbird populations and change the species composition on the disturbed area through long-term elimination of the varied habitat types, probably with concomitant reduction in the numbers and varieties of insects that the birds depend on. Impacts would be confined largely to the 4420 acres of habitat actually changed by mining and would thus not be of great significance on a subregional basis. Mining would eliminate 2,260 acres of sagebrush/grass habitat used by Brewer's and vesper sparrows, and that habitat loss would probably last for many decades. Similarly, at least 147 acres of sandstone outcrop and ponderosa pine habitat used by chipping sparrows, cliff swallows, loggerhead shrikes, rock wrens and Say's phoebes would be permanently eliminated.

7. AMPHIBIANS AND REPTILES

Adverse impacts from the proposed action on amphibians would likely affect primarily the reproductive requirements of frogs and toads. Loss of existing wetlands used as breeding and rearing areas would adversely impact frogs and toads for the life of the mine, however, suitable areas for their reproduction are expected to develop following mining. Snake denning areas (rock crevices) would be lost to mining and the abundance of their food (small mammals and insects) would be permanently lowered.

8. ENDANGERED SPECIES

There would be no impact to endangered wildlife species.

9. FISHERIES

There would be no impact to fisheries resulting from the proposed operation.

H. SOCIOLOGY

If the proposed Spring Creek mine is permitted, it would contribute additional impingements on the quality of life for those living in the Birney-Sheridan area. Those living in Big Horn County would primarily be impacted by the actual mining activity. Those living in Sheridan would be impacted primarily through new demands placed on the community and on individuals resulting from a large number of new people moving into the area. Some people would benefit through immediate economic gains; however, the general social and psychological well-being of the area can be expected to decline unless mitigated through creative and responsive planning. Although the addition of the Spring Creek mine would contribute significantly to an already impacted area, the cumulative impacts of all the mining and related activity would have a far greater and more serious impact on local society.

1. POPULATION

The location of the proposed Spring Creek mine would have a major effect on population characteristics in Sheridan County, Wyoming and a negligible effect in Big Horn County, Montana, where the mine will be located. Because of the residential and trade patterns that have been established in Big Horn and Sheridan counties, the primary towns effected by mining induced population growth will be Sheridan county towns and more specifically the town of Sheridan. The town of Hardin in Big Horn county will experience little if any population growth from the Spring Creek mine.[1]

Population would increase by 2,882 between 1978 and 1990 (27%) in Big Horn County (the same as the base increase without the Spring Creek Mine) while Sheridan County would experience an increase in population of 5,273 (23%) by 1990. This is an increase in population for Sheridan County of 5,273 with the addition of the Spring Creek Mine between 1978 and 1990. (A 23% increase with the Spring Creek Mine as opposed to 19% or 4,355 without the Mine). The city of Sheridan would grow by 30% from 1978 to 1990.[2]

Table III-2 shows the estimated population changes that will occur in Big Horn and Sheridan counties. It is important to realize

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[1] It was assumed that miners employed at the new Spring Creek Mine as well as those employed at Decker Mine would continue to reside in Sheridan County. The only miners residing in Big Horn County are assumed to be from the Westmoreland Mine.

[2] The population value for the city of Sheridan in 1978 is somewhat higher relative to the model computation.

that major changes will occur in Sheridan county's perponderance of non-Indian residences. The Indian population in Sheridan County is not expected to increase from its current very small percentage of the total population. The Indian population in Big Horn County will remain basically very large (refer to Chapter II population).

TABLE III-2.--Population projections with addition of Spring Creek mine

Year	Big Horn Co.	Sheridan Co.	Town of Sheridan
1978	10,609.	23,165.	16,412.
1979	10,600.	23,529.	16,776.
1980	10,694.	23,533.	16,780.
1981	10,985.	23,972.	17,219.
1982	11,160.	24,316.	17,563.
1983	11,341.	24,631.	17,878.
1984	11,533.	24,957.	18,204.
1985	11,733.	25,292.	18,539.
1986	11,975.	25,706.	18,953.
1987	12,222.	26,131.	19,378.
1988	12,474.	26,554.	19,801.
1989	12,729.	26,790.	20,217.
1990	13,491.	28,438.	21,385.

Although population changes induced by the establishment of the Spring Creek mine will be significant most of the population impacts will occur in areas in Sheridan county. Rural areas in Montana will experience population effects basically as a result of increased work related and recreational people moving about the area. Little settlement is expected in the rural areas of Montana from the Spring Creek mine related population.

2. SOCIAL ORGANIZATION

The impacts in social organization that would result from approval of the Spring Creek mine are discussed in terms of the key components of the quality of life: social well-being and psychological well-being.

a. Social Well-being

Social well-being would be affected by change in the institutions and groups which reflect community values, goals, and everyday activities. The changes would be greatest in the Sheridan urban area but change would also occur in the rural communities of Big Horn County.

Changes noted by Gold (no date) include shifts in the selection of friends, strains in communicating with friends and neighbors of long standing, a shift in the established power structure from the ranchers to the new mining industrialists, the need to live with constant and increased uncertainties for which planning is virtually impossible, a keen interest on the part of some merchants and businessmen in immediate monetary gain, the need to accommodate to the invasion and requirements of newcomers who subscribe to foreign life-styles and value systems, and loss of a sense of community. These existing conditions suggest that a state of "simple anomie" (Merton, 1968) already exists in the Birney-Sheridan area. Increased mining activity, expanding at its projected pace, would concentrate and exacerbate this condition.

Social well-being can be evaluated in terms of the five categories described below (Fitzsimmons, et. al., 1977). Although there is a lack of data with which to examine all components of these categories in depth, it is possible to examine each in a general sense.

(1) The viability and stability of communities in Big Horn and Sheridan Counties would be changed as large numbers of new residents move into the area. Community services and facilities would be the first to be affected. There would be a period of a few years or more between the onset of increased demands for services and facilities and expansion to meet the new needs. The duration of this lag period would depend on the timing of mine openings, the responsiveness of local government, and on the availability of new tax revenues. Since the new mines would be located in Montana, new revenues would depend mostly on increased property valuations, sales taxes, or State or Federal aid. Tax burdens could be increased for long term residents.

(2) The achievement of economic stability and improved personal income would be reduced for some and enhanced for others.

New jobs would be created at the mines and in Sheridan County. Competition for skilled labor would cause wages to increase in an area where they have traditionally been low. This in turn would boost prices. Workers with the necessary skills would benefit, while unskilled workers and agricultural employers might not benefit.

Merchants in the area would benefit initially from higher prices and increased demand. New businesses and chain stores might locate in the area, however, providing price competition and perhaps replacing some existing firms.

Housing would become more expensive and would place a burden on people with fixed or low incomes.

(3) Population distribution would change. As mine-related growth increases, the desirability of Sheridan as a regional retirement center appears to decrease. As young unmarried males move into the area, the ratio of males to females would increase. Schools would become more crowded due to an increase in the number of young families with school age children.

(4) As Sheridan becomes more crowded, it would become harder for people to enhance the security of life and health. Noise, air pollution, crowding, mud, water pollution, and littering would increase, thus lowering the beauty of the town and the healthy nature of the environment. Crowding and an increase in pollution, where mitigation is unlikely, tends to increase the probability of mental and physical illness (Cassel, Patrick and Jenkins, 1960; Leighton, 1974). The expected increased crowding in housing may also affect mental and physical health.

Since formal opportunities for recreation are primarily limited to movie theaters and bars, construction workers tend to take over local bars as a major mode of relaxation. There are commonly fights and incidents which make the bars less desirable for those who formerly frequented them and thought of them as "their own" neighborhood bars. Such problems can be expected to increase (Schmidt, 1966).

(5) Local governments would become less stable as the influx of additional permanent residents shifts political power away from its traditional base. Permanent mine workers, ancillary employees, and their families will be more likely to take part in local politics because their jobs are more permanent than those of construction workers.

b. Psychological Well-being

Approval of the proposed Spring Creek mine would contribute to a decrease in the psychological well-being component of the quality of life. Psychological well-being is a function of an individual's interaction and the quality of relationships with the social and physical environment. Approval would also contribute to the trend towards the breakdown of traditional social organization.

The breakdown of social organization interferes with the process of individuals meeting what Maslow (1968, 1970) calls growth needs. Failure in personal growth results in "neuroses" and "pathologies". The decrease in a sense of worth and meaning and the interference with personal growth is manifest in what Kohrs (1974) has described as the Gillette Syndrome. This syndrome refers to the increasing incidence of drunkeness, divorce, delinquency, depression, and even suicide in rural western boomtowns. Although the description above is not indicative of the present condition in the Birney-Sheridan area, there are increasing indications that a similar trend is developing in the region.

Most of the newcomers to Sheridan County would tend to be temporarily isolated from the existing community. Families of construction and mining workers who settle in mobile home parks would be most severely affected. There are limited social, cultural, and educational opportunities for the wives of construction workers. Children whose parents frequently change job locations often have trouble with school. Child abuse, juvenile delinquency, and alcohol and drug abuse could be expected to increase.

Professional help with mental health, child guidance, and alcohol and drug abuse is available in Sheridan, but services are severely strained now. Increasing demands for these services could not be met without substantially increased budgets and staff.

Subtle impacts on psychological well-being are caused by frustrating situations such as increased noise and traffic, waiting in line where one never had to wait before, and a decline in the quality of services. Situations such as these are already occurring in the urban portions of the study area. Information on the existence of similar problems in the rural areas is not available.

I. ECONOMICS

Approval of the proposed Spring Creek Mine would cause impacts through changes in employment, population, public finance, and income. With an increase in economic activity, indirect impacts would occur to community services and social organization.

1. EMPLOYMENT

Mine plan approval would generate additional employment at the mine site in Big Horn County. Because of the lack of urban development in Big Horn County, it is assumed that these miners would reside in Sheridan County. Construction employment would commence in 1979 with the establishment of the mine facilities and would end in 1980. At peak construction 480 workers would be employed. Mining employment would begin before the end of the construction period in 1980 and continue throughout the life of the mine. It is estimated that a force of 253 miners would be required to mine the 10 million tons of coal per year. Table III-3 depicts the expected number of miners by residence for both counties between 1978 and 1990. The majority of these miners would reside in Sheridan County[1], although many would be employed in Big Horn County[2].

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[1]Much speculation has been going on in Southern Big Horn County concerning a new town but at present, plans have not been completed. Table III-3 includes mine construction workers.

[2]The majority will be employed at the Spring Creek and Decker Mines in Big Horn County, MT.

TABLE III-3.--Mine employees residence (1978-90)

Year	Big Horn Co.	Sheridan Co.
1978	195.	864.
1979	153.	934.
1980	153.	854.
1981	210.	949.
1982	210.	949.
1983	210.	949.
1984	210.	949.
1985	210.	949.
1986	210.	949.
1987	210.	949.
1988	210.	949.
1989	210.	949.
1990	210.	949.
1991	210.	949.

Table III-4 compares the employment changes in Sheridan County with and without additional employment at the Spring Creek Mine. The increase in total employment in Sheridan County by 1990 would be 536 workers if the proposal where approved. Ancillary employment would increase by 283. However, Big Horn County shows no employment changes in the base, ancillary, and total employmemt since the workers from the Spring Creek Mine would reside in Sheridan County.

The estimated increases in employment resulting from the establishment of the Spring Creek Mine would result in higher population and income in Sheridan County. Estimates indicate that there would be a migration of people from Sheridan following the mining construction. The out-migration would be only a temporary pattern (See Appendix I).

The employment/population ratio (the number of people employed divided by the total population) for both counties will increase during the early 1980's, but will decrease to the 1970 levels in the latter part of the decade. Approval of the Spring Creek Mine would have an insignificant effect on the overall ratio over a long period of time (see Appendix I for these county estimates).

2. INCOME

Increases in employment related to the Spring Creek Mine would cause an increase in total personal income in the two-county area. More specifically, the majority of the annual payroll received by operational

TABLE III-4.--Employment projections, Big Horn and Sheridan Counties (1978-90)

Year	Big Horn County Base Employment	Ancillary Employment	Total Employment	Sheridan County Base Employment	Ancillary Employment	Total Employment
BASE LINE EMPLOYMENT WITHOUT SPRING CREEK MINE*						
1978	2,244.	2,264.	4,508.	4,411.	6,234.	10,645.
1979	2,202.	2,346.	4,548.	4,181.	6,290.	10,471.
1980	2,202.	2,445.	4,647.	4,281.	6,381.	10,662
1981	2,259.	2,573.	4,832.	4,281.	6,511.	10,792.
1982	2,259.	2,679.	4,938.	4,281.	6,636.	10,917
1983	2,259.	2,783.	5,042.	4,281.	6,759.	11,040.
1984	2,259.	2,889.	5,148.	4,281.	6,881.	11,162
1985	2,259.	2,996.	5,255.	4,281.	7,003.	11,284.
1986	2,259.	3,104.	5,363.	4,281.	7,124.	11,405.
1987	2,259.	3,213.	5,472.	4,281.	7,253.	11,534.
1988	2,259.	3,323.	5,582.	4,281.	7,380.	11,661.
1989	2,259.	3,434.	5,693.	4,281.	7,503.	11,784.
1990	2,259.	3,546.	5,805.	4,281.	7,623.	11,904.
PROJECTED EMPLOYMENT WITH SPRING CREEK MINE						
1978	2,244.	2,264.	4,508.	4,449.	6,251.	10,700.
1979	2,202.	2,346.	4,548.	4,519.	6,446.	10,965.
1980	2,202.	2,445.	4,647.	4,439.	6,547.	10,986.
1981	2,259.	2,573.	4,832.	4,534.	6,679.	11,213.
1982	2,259.	2,679.	4,938.	4,534.	6,836.	11,370.
1983	2,259.	2,783.	5,042.	4,534.	6,967.	11,501.
1984	2,259.	2,889.	5,148.	4,534.	7,098.	11,632.
1985	2,259.	2,996.	5,255.	4,534.	7,231.	11,765.
1986	2,259.	3,104.	5,363.	4,534.	7,363,	11,897.
1987	2,259.	3,213.	5,472.	4,534.	7,504.	12,038.
1988	2,259.	3,323.	5,582.	4,534.	7,641.	12,175.
1989	2,259.	3,434.	5,693.	4,534.	7,775.	12,309.
1990	2,259.	3,546.	5,805.	4,534.	7,906.	12,440.

* These data are the same estimates made available in Chapter II given that other mines in existence continue without the introduction of the Spring Creek mine.

workers would be spent in Sheridan County. It is highly probable that during construction, much of the construction payroll would be spent in Sheridan County also. Incomes in Sheridan County would be increased by a multiplier effect of approximately two. This secondary income effect would continue throughout the life of the Spring Creek mine.

Estimates based on the analysis of the model studies indicate that over the life of the Spring Creek Mine ancillary wages would increase continously to 1990 in both counties. Further evidence shows that the level of ancillary wages would be higher for Sheridan County from 1978 to 1990 with the Spring Creek Mine than without the mine.

The majority of the financial benefits resulting from the operation of the mine would be distributed among the businesses in the area, and those involved in the mining and construction sectors. Individuals with fixed incomes (primarily the elderly) and the poor would be in a less favorable financial position, because prices would generally increase more rapidly than income during boom conditions. New jobs and high incomes would make it possible for many young people of the local area to remain: lack of opportunity for employment in the past made it necessary for many young people to seek employment in other regions.

3. FISCAL CONDITIONS

With the addition of the Spring Creek Mine state, county, and school district revenues are estimated to increase in Big Horn County[1]. Although the revenue for the town of Hardin is estimated to grow, approval of the Spring Creek Mine would not add any additional revenue to the city of Hardin. It is estimated that revenue for the city of Hardin would increase between 1978 and 1990 and that the county and school districts would receive additional funds (Table III-5). Revenues to the State of Montana also would increase substantially from the additional taxes generated from the Spring Creek Mine. (See Table III-5).

The majority of the negative fiscal impacts would occur in Sheridan County. It is estimated that there would be small differences in the amount of revenue to Wyoming that would result from the approval of the Spring Creek Mine. County and school district fiscal conditions are shown in Table III-5 for purposes of comparing with and without the Spring Creek Mine. These values are only estimates of the county and school distrcits in Sheridan County experiencing shortfalls. Under Wyoming law, Sheridan County would not face actual deficits as projected. The deficits indicated are the result of the Coal Town II Model analysis which assumes that the mill levy remains constant. The Sheridan County school districts would gain a difference of approximately 300 school children by the year 1990 with the addition of the Spring Creek Mine.

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[1] Estimates made by Coal Town II Model, Montana State University, Bozeman, MT.

TABLE III-5.--Projected fiscal conditions--A comparative analysis with the addition of the Spring Creek mine,[1] Big Horn and Sheridan Counties, 1978-90

With the addition of the Spring Creek mine											
	Big Horn County						Sheridan County				
Year	State revenue	County surplus	School surplus	School children	Hardin revenue per head	State income tax derived from coal mining	State revenue	County surplus	School surplus	School children	Sheridan revenue per head
1978	33,157,696	584,925	1,099,620	2,785	134	1,240,921	2,920,703	-4,995,746	117,301	6,082	94
1979	41,856,704	1,182,550	2,550,634	2,783	137	1,341,906	4,642,104	-5,251,832	235,539	6,177	101
1980	62,451,840	904,096	3,424,281	2,808	143	1,227,172	4,686,206	-5,617,345	-94,374	6,178	100
1981	86,391,168	1,486,474	5,344,001	2,884	148	1,363,684	5,248,136	-9,340,062	-4,768,031	6,294	108
1982	96,625,344	2,124,408	7,411,076	2,930	155	1,363,684	5,367,356	-7,039,418	-1,501,524	6,384	106
1983	109,646,768	2,196,441	7,659,450	2,977	161	1,363,684	5,786,637	-8,882,557	-3,712,742	6,467	111
1984	116,765,152	2,297,750	7,978,897	3,028	167	1,363,684	6,175,357	-10,122,232	-5,121,022	6,522	115
1985	122,960,544	2,383,311	8,240,049	3,080	174	1,363,684	6,542,640	-10,838,996	-5,827,830	6,640	118
1986	129,460,464	2,381,758	8,203,957	3,144	180	1,363,684	6,986,445	-12,444,315	-7,679,437	6,745	122
1987	135,932,176	2,525,516	8,640,072	3,209	186	1,363,684	7,317,806	-11,781,085	-7,965,836	6,860	124
1988	143,121,904	2,605,404	8,858,550	3,275	192	1,363,684	7,786,087	-13,634,702	-8,676,830	6,971	128
1989	150,676,784	2,698,368	9,113,276	3,342	199	1,363,684	8,242,036	-14,547,349	-9,580,545	7,081	131
1990	160,184,080	2,262,275	7,440,010	3,542	199	1,363,684	12,671,620	-19,891,56?	-15,647,843	7,48?	157

Without the addition of the Spring Creek mine											
	Big Horn County						Sheridan County				
Year	State revenue	County surplus	School surplus	School children	Hardin revenue per head	State income tax derived from coal mining	State revenue	County surplus	School surplus	School children	Sheridan revenue per head
1978	33,157,696	584,925	1,099,620	2,785	134	1,186,345	2,906,476	-4,978,358	119,701	6,060	94
1979	41,856,704	1,182,550	2,550,634	2,783	137	856,292	4,511,409	-5,080,560	269,792	5,975	101
1980	56,173,488	705,776	2,768,750	2,808	143	1,000,131	4,829,540	-8,541,645	-4,083,961	6,041	100
1981	70,975,984	999,209	3,728,475	2,884	148	1,000,131	5,039,452	-7,829,728	-2,949,402	6,114	108
1982	73,475,824	1,392,383	4,984,046	2,930	155	1,000,131	5,353,567	-8,300,606	-3,361,428	6,188	106
1983	85,352,352	1,430,256	5,119,164	2,977	161	1,000,131	5,688,359	-9,030,105	-4,112,156	6,263	111
1984	91,235,440	1,495,511	5,319,074	3,028	167	1,000,131	6,035,880	-9,752,543	-4,847,053	6,341	115
1985	96,130,416	1,543,095	5,454,315	3,080	174	1,000,131	6,395,248	-10,419,168	-5,498,763	6,420	118
1986	101,263,808	1,501,450	5,285,295	3,144	180	1,000,131	6,832,805	-11,991,832	-7,317,698	6,524	122
1987	106,292,800	1,603,121	5,581,873	3,209	186	1,000,131	7,158,706	-11,333,901	-7,587,934	6,622	124
1988	111,965,168	1,638,619	5,653,174	3,275	192	1,000,131	7,617,289	-13,122,602	-8,261,736	6,724	128
1989	117,923,856	1,684,720	5,752,541	3,342	199	1,000,131	8,064,088	-13,991,168	-9,119,688	6,825	131
1990	125,754,704	1,199,346.	3,919,876	3,542	199	1,000,131	12,463,632	-19,105,472	-14,897,783	7,101	157

[1]Estimates made from the Coal Town II Model, Montana State University, Bozeman, MT

However, either with, or without the Spring Creek Mine, there will be substantial growth in the number of students attending high school and grade school in Sheridan County.

4. INDIANS AND INDIAN RESERVATIONS

If the Spring Creek mining plan is approved, Indian population and the Indian reservations (Crow, Northern Cheyenne) would experience certain additional impacts. The major impacts would be: (1) increased flow of traffic through the reservations by construction workers and miners traveling to and from the Spring Creek Mine for both work and recreational purposes, (2) social and political confrontations would increase because of cultural differences between the Indians and mine workers, (3) tribal administration of public services on the reservation would be complicated and become more expensive because of the need for game wardens, etc.; (4) Indian incomes would probably lag behind miner incomes as miners and construction workers would receive nationally established union wages.

No additional employment, income, or population changes would be expected to occur on the reservations as a result of the Spring Creek Mine being established.

J. COMMUNITY SERVICES

The impact on the entire spectrum of community services would be radically different if the proposed new town is built at Decker. However, since there is no assurance that the town will ever be built, this chapter will assume existing conditions.

The introduction to the Chapter II Community Services section outlined a group of problems common to all community services. If the Spring Creek mine is permitted, community services that have currently reached the upper carrying capacity limits would become stressed to an even larger degree. The school district with capacity may remain untouched while the overloaded district must cope with hundreds of new students. The cost for these developments must be paid by revenues generated from property tax. In many cases the additional development costs present unfair burdens on the local tax payer.

1. HOUSING

Since the existing trends in housing in Sheridan County have been induced largely by coal development, it is most probable that similar trends will continue. Based on trendline population projections, Sheridan Area Planning Agency (SAPA) expects the number of needed housing units in 1980 to be 8,188, in 1985 to be 9,955 and in 1990 to be 11,870.

The vacancy rate of 0.9% in Sheridan will continue or decline even further. The vacancy rates in Ranchester and Dayton would most likely decline further since, relative to Sheridan, there is available housing in the outlying towns.

The construction of single family units would increase. Increasing prices would limit their availability to the more well paid. It is doubtful that the percentage of the single family dwelling (SFD) housing stock would increase much further.

Mobile homes would increase in numbers and as a percentage of the housing stock. The inability of people to wait for housing and the high prices will force many people into trailers.

The multi-family units planned and under construction in Sheridan would raise the number and percentage of such units. For those able to afford them, multi-family units, if well designed, would be an attractive compromise between mobile homes and single family dwellings.

In some cases the existing owners of older, run-down homes may find it increasingly difficult to spare money for maintenance. Short term construction residents may have little incentive to upgrade their housing. However, the more permanent employees would probably take much more of an interest in maintaining their housing.

The price of housing would continue its increase. With a rapid increase in demand and extremely low vacancy rates, new and old housing would become increasingly expensive. New housing built under such conditions and in an inflationary area would be increasingly difficult to afford for low income people. Rents, especially, would reflect the monetary demands and would rise.

Existing families, especially those with lower fixed incomes, would be under considerable pressure. Property taxes, rent and mobile home park rent would rise substantially. Some of these families may be forced out of their housing into something more affordable, if it is available. Many of these people may be forced into some kind of housing assistance.

Inflated housing and land values concurrently have a beneficial effect. Landlords are induced to maintain rentals, because higher rents can be obtained for maintenance costs.

2. WATER

a. Sheridan City

The City water system should be adequate for the near term. In excess of $1.5 million is being spent on improved distribution mains.

Depending on the extent and timing of local and Montana development, the system could easily become overloaded, thus requiring extensive and expensive additions to the system. A serious problem has been and will be the annexation of lands to the city before water is provided. Extensive annexation can also create local overloads to the water system.

b. Ranchester

The town has part of and is applying for the rest of an $853,000 grant to upgrade the water and sewer systems. Until the water and sewage facilities are completed, Ranchester may have difficulty providing adequate service during growth periods.

c. Dayton

The town's water system is presently deficient. A $150,000 Federal grant has been awarded to the town for upgrading of the water system. Until the system is constructed, Dayton will find it difficult to cope with additional growth.

d. Rural Sheridan County and Decker Area

The growth outside the incorporated towns will require small, subdivision water systems, or individual wells.

3. WASTEWATER TREATMENT

a. Sheridan

The City's sewage treatment plant would come under increasing pressure as new people move in. Depending on the spatial distribution of the new growth, existing collection system overloads would worsen and/or new ones occur. As increasing volumes of waste flow into the plant, it would decline in efficiency of treatment even further. Until the discharge standards are enforced, probably little would be done. Implementation of Powder River Area-wide Planning Organization (PRAPO) recommendations for the system would cost around $2.5 million.

b. Ranchester

Part of the $150,000 grant would go to upgrading the sewage system. Until the new plant is operational, sewage treatment would be increasingly inefficient, releasing greater quantities of untreated sewage to the Tongue River.

c. Dayton

Any further growth in Dayton would increase the existing problems with the sewage treatment lagoon. The impact of the existing, major seepage problem is not known, and it is therefore impossible to

indicate the impact of additional seepage. It can be safely said that an extremely serious health hazard may exist and would worsen with further growth.

d. Rural Sheridan and Big Horn Counties

The major potential impact of scattered rural development without strict controls, is the possible contamination of water sources by improperly designed, installed or maintained septic systems.

4. SOLID WASTE

a. Sheridan

An increasing growth rate in the County would shorten the lifetime of the single landfill available. This would hasten the need for additional site(s). There will also be an increase in scattered dumping.

b. Big Horn County

The proposed solid waste management plan should adequately serve the Decker area. The intention to place containers in the Decker area should reduce scattered dumping. Until the plan is effective, there would be more people disposing of trash at traditional and new dump sites.

5. SCHOOLS

If the Spring Creek mine is approved, impacts on the school system would come from four groups of people, the construction workers and the operating workers from Spring Creek, the workers from other developments in the region, and the secondary, induced employees and their families.

The construction phase of Spring Creek would last about two years with the work force peaking at 480 the second year. The Old West Regional Commission Construction Worker Profile found that on the average, slightly over 60% of the construction force were non-local. (Present address is different before beginning of the project. This apparently does not capture those moving to an area in anticipation of work). Of these, nearly 25% were single, slightly more than 25% were married with families not present and just under 50% were married with families present. The construction worker profile at Spring Creek is assumed to be similar. A total of 475 people are expected to come into the area as a result of the 480 jobs with the construction of the Spring Creek mine. Of the total influx of 475 people, approximately 123 would be school age children and would attend the Sheridan County schools[1].

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[1]Estimation generated from Coal Town II Model.

These people would reside in the Sheridan area only until construction activities were completed. A total of 522 people are expected to come into the area as a result of the 253 miners employed for the Spring Creek mine. Of the total of 522 people, approximately 137 would be school age children and would attend the Sheridan County schools.

6. HEALTH FACILITIES

a. Hospitals

The Sheridan County Hospital is currently crowded, overworked and inadequate to satisfy health demands placed on it. Substantial additions or replacement is needed. Any additional population will place more stress on the facility and reduce the adequacy and efficiency of service. There will most likely be little impact on any other hospital facility in the region.

b. Health Personnel

Sheridan is well supplied with physicians and other health care personnel due to its role as a regional center. In order to maintain this role and to provide for local needs, additional people will probably be needed. Any growth which may occur in Big Horn County would cause further problems since it is currently understaffed in terms of medical facilities.

c. Nursing

The existing and planned facilities are considered adequate for foreseeable needs.

7. LAW ENFORCEMENT

Based on experience in towns with rapid growth rates, it is expected that crimes would increase. This would put a strain on the existing police personnel and facilities and would require more officers and equipment. The smaller towns and rural areas which are presently inadequately staffed and equipped would have the hardest time coping with the impact. Unless additional funding is made available, the level of protection can only decrease.

8. FIRE PROTECTION

The exact impacts on fire protection are impossible to identify without knowing how mahy people would live in a given area. However, it is generally assumed that most of the increase population if the Spring Creek mine is approved would live in the city of Sheridan. It is probable that some of the people would settle in rural areas or on the fringes of existing towns. This would require additional protection in already poorly served areas. Wherever people settle, required fire-

flows would increase and required response times would decrease. Some areas, particularly Dayton and Ranchester would have increasing problems providing service at all much less adequate service. The improvements to the Ranchester water system would only partially help the fireflow deficiencies.

Increasing expenditures would be necessary in order to maintain existing levels of service. It is probable that as areas develop, there would be a demand for improved levels of service which would require even more expenditures.

K. LAND USE

1. LOCAL IMPACTS

The major direct land-use impact of the proposed action would be the conversion of nearly 7 square miles of a largely natural rural landscape to an industrial (strip mine) complex. This would be significant because it entails major changes affecting all land uses and values including esthetics, recreation, agriculture, wildlife, and watershed. This would involve conflicts between many of the existing uses and mining. Secondary impacts would occur as lands in the area (most critically, agricultural land) are converted to urban uses.

The 4,420 acres within the permit area would be diverted from its present livestock grazing, wildlife, and watershed use to mine pits, mine facilities, and eventually to a reshaped and revegetated surface on the mined-over portion.

At the end of the 25-year life of the mine the entire area is proposed to return to present kinds of uses.

All livestock were removed from the mine site in late 1977 to allow range recovery, resulting in approximately 795 annual unit months (AUM's) per year being unavailable to the local livestock economy for a minimum of 2 years. Should livestock be reintroduced in later years, carrying capacity may be substantially improved but the area available would fluctuate as mining advances and the reclamation cycle begins.

No current cropland would be impacted by the proposal; however, the permit area contains 1,705 acres of soils in land-use capability classes III and IV, which have the potential for cropping use under appropriate management (see Soils, Chapter II). This potential would be unavailable through the period required for revegetation to native plants.

Building of the proposed Spring Creek rail spur and access road would cause the loss of about 250 acres of rangeland. In addition, the ranching operations crossed by these corridors would be inconvenienced to the extent that existing pasture units are fragmented. A portion of

the rail spur might be retained beyond the life of the proposed mine if additional mines were located which could make use of the track. If a portion of the rail spur were removed after mining had ceased and the land was reclaimed to sustain vegetation again, 10 to 15 years might be necessary before vegetation suitable for grazing could be reestablished.

Exploration and development by oil and gas lease holders within the permit area could be delayed during the cycle of mining and replacement of overburden. Impacts on potential development of oil and gas from the construction of the mine access road or the transportation corridor should be negligible since these rights-of-way are sufficiently narrow, and provide no serious hinderance to testing or developing any particular oil or gas structure.

No residences, public roads, private rights-of-way, or special use permits exist to be impacted within the permit area.

Impacts related to esthetics, recreation, wildlife and watershed are addressed in those sections.

2. REGIONAL IMPACTS

In the surrounding areas, including Sheridan, transitions in land use are taking place due to the influx of new population. Restrictive city zoning, inflated land prices, and community growth contribute to the location of housing developments in less regulated areas. The greatest impact from this is the loss of fertile flood plains and croplands, resulting in a reduction in productivity of the agricultural sector (Chapter III, Economics). Additional problems are created as counties and municipalitites encounter fiscal problems and as service deficiencies develop (Chapter III, Community Services).

Additional residential acreage would be required in Sheridan and nearby small communities (Chapter III, Community Services). Some of the new workers would seek residences nearer the mine in rural trailer courts or on individual rural acreages. How this demand would be distributed is difficult to predict at this time because it depends not only upon individual worker's preference but also on separate decisions by local governments, private developers, and land owners in the area.

Using Sheridan Area Planning Agency (SAPA) figures for total housing units in Sheridan an average estimated 0.16 acres are required per unit. Assuming Spring Creek employees and the resulting ancillary population would require 374 housing units built to Sheridan's average density, at least 60 acres of land would be converted to housing developments to support the Spring Creek mine. If residents settled in suburban or rural areas, the acreage needed would be greater. If all new units were developed on 0.25-acre lots, 94 acres would be used. If 0.5-acre lots were developed, 187 acres would be used.

The most probable locus of population growth resulting from coal development along this portion of the Montana-Wyoming border is Sheridan County. And because the city of Sheridan is the most developed, the largest proportion of the new population would be expected to reside there. However, a number of conditions which suggest that other communities, most notably Ranchester and Dayton, would bear a considerable share of the impact. These conditions include: the availability of housing in Sheridan, transportation linkages which facilitate access to Ranchester-Dayton, and the atmosphere of receptivity to growth in the various communities.

Based on extensions of current growth patterns, an approximate distribution of population within Sheridan County can be projected. If all of the population growth occurs in Sheridan County, each of the three incorporated municipalities would be assumed to receive the following proportions of the increment: Sheridan 50.6 percent, Ranchester 11.2 percent, Dayton 4.7 percent.[1]

Commercial sites and other land uses of an urban character would increase in proportion to residential land development. The small community of Decker would experience significant residential and commercial impact from this project. As population increases in the surrounding area more land would be needed for telephone and electrical service rights-of-way, water and sewer service where concentrated growth occurs, upgrading of existing roads, and construction of new roads to residential properties.

Regional impacts on agricultural, recreational and wildlife lands are treated under these headings in this chapter.

3. CUMULATIVE LAND USE IMPACTS

The 4,420 acres encompassed in the Spring Creek application would be added to the 10,105[2] acres contained in the 3 existing mines in the vicinity (Southern Big Horn Co. Montana and Northern Sheridan Co., Wyoming). An estimated additional 8,136 acres are expected to be added to this area total in the next few years.[3]

Sixteen miles of rail spur covering about 228 acres would be required for railroad access to the Spring Creek mine. At least another 20 miles of rail line on an estimated 485 acres would be needed to connect the other proposed new mines in the area to the Burlington Northern main rail line. Additional miles of access road, expansion of existing road, and proportionally greater acreages of residential com-

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[1] This distribution will be entirely different if a new town is developed near the proposed Spring Creek Mine.

[2] Decker, Big Horn, and Ash Creek mines.

[3] North Extension of Decker, Shell Pearl, and Consolidation CX mines

mercial, and public use lands would be needed as other area mines are developed. Spring Creek would contribute to pressures toward the creation of one or more new towns in the immediate vicinity.

Major land-use changes associated with these mines would be felt over a period of 20-40 years, as each mine progresses through the cycle of development to exhaustion of the recoverable reserves.

Since rehabilitation measures would be implemented as mining progresses, the total number of acres disturbed during the life of these mines would not be converted to a different land use at one time, but would constitute a rotation in land use, spaced over the life of the mine.

The more permanent changes in land use would be provided by roads, railroads, powerlines, office and maintenance shop buildings, and the induced urban and residential development.

Rural areas not subject to stringent land-use controls and landdevelopment regulations may be adversely impacted by scattered development, and thus would affect adjacent land values.

4. IMPACT ON PLANNING

One of the important impacts of coal development on local governments and communities would be the necessitation of expansion of planning programs. The rapid growth and associated strains on all aspects of government and society would break down the traditional reluctance to plan.

L. TRANSPORTATION SYSTEMS

The major impact on the present transportation system due to mining at Spring Creek would be an increase in volume on existing transportation modes. This would result in increased accident rates, system deterioration, rising maintenance costs and decreased efficiency if not mitigated.

Employment of construction workers and permanent mine employees at Spring Creek is expected to bring 374 new households into the area by 1981. Most families have one or more vehicles which would add to existing street and highway use, parking space demand, and demand for vehicle repair and services. These additional people would also increase the usage of air and bus service on the route through Sheridan, Billings and Casper.

1. HIGHWAYS

Traffic volume on highway FAS 314 would increase proportionate to construction and mining activities. Fluctuations would occur relative

to the degree of overlap between mining and construction activities. Traffic is expected to be heavy when shift changes occur and would be particularly heavy if the shift changes were to occur at the same time as those of other mines in the area.

Highways I-90, Wyoming Secondary Route 338, U.S. 87, and U.S. 212 would also receive heavier traffic as a result of the mine. The impact of the increased traffic from the Spring Creek mine would be comparatively small. However, there could be a minor increase in the accident rate on these highways.

The increased highway use would also lead to accelerated deterioration, and thus a reduction in capacity, especially for FAS 314. Unless serious deterioration occurred due to increased use by heavy trucks, this route is unlikely to be improved before 1985. Accident rates would increase due to the increased volume; however, system deterioration would also increase public expenditures required for maintenance or reconstruction.

System efficiency would decrease as traffic delays occurred at grade crossings. These delays would become more important as both vehicle volume and the number of unit trains per day increased. During the first year of production, 10 to 12 unit trains per week would be crossing the highway. At full production, approximately 40 trains per week would block the highway crossing; an average of 5.5 minutes per train. This would impede traffic approximately 3 hours and 40 minutes per week.

Equipment malfunctions would probably cause occasional delays of as much as 30 minutes or more at the crossing (Montana Highway Department Public Hearing, December 1976). These delays would inconvenience local ranchers and other residents, mine workers, school buses, mail and other deliveries, and--perhaps most seriously--emergency vehicles to Sheridan. The potential for car-railroad accidents would increase.

2. RAILROADS

The major impact of the Spring Creek mine upon the railroad system would be to increase traffic by about 300 unit train round trips during the first year of production, increasing to about 1,000 round trips per year at peak production. On the Decker spur, these increases would amount to 28 percent and 93 percent, respectively. Each loaded unit train would represent a round trip; therefore, traffic passing any point along the route would be twice the number of loaded trains. This traffic would require additional coal cars, locomotives, personnel, and increased maintenance of equipment and rights-of-way. Destinations are not known at this time, but coal trains would join the Burlington Northern mainline at Wyarno, Wyoming.

3. CUMULATIVE TRANSPORTATION IMPACTS

When coal produced at Spring Creek would leave the mine spur, it would travel over tracks also serving other local and regional mines and other local and regional rail users. Spring Creek traffic would add to impacts from already existing, or soon to be initiated, traffic in the general area. Locally, Spring Creek traffic would be added to the traffic generated by the existing Decker mine and the expected increase from opening the Decker East and North extensions. Table III-6 shows the estimated cumulative local traffic that would be generated by these mines at full production and approximate at-grade crossing delay times.

Impacts from grade-crossing delays and increased potential for accidents would be felt all along the route, from the mines to the coal destination. No specific statement can be made about the duration of these delays or the degree of hazard since these vary widely with each crossing.

Delays estimated in table III-6 were from observation of train movement near the loading or destination point. In open country a 7,000-foot-long train passing at maximum allowable speed (50 mph) would require just over 1.5 minutes to clear the crossing. Additional delay results from the necessity of halting traffic at a safe interval from the crossing before the train reaches the crossing and a short interval for traffic flow to resume after passage. Train speeds through crossings are influenced by a variety of factors including grade, track conditions, proximity to scheduled stops, or speed restrictions imposed by towns and cities on the route.

M. RECREATION

The fencing and excavation of the proposed mine would result in a negligible impact on recreation, because most of the 4,420 acres of potential recreational use in the Spring Creek permit area are privately onwed and not now open to public access. Secondary impacts would be increased use of nearby public and private lands and existing recreation facilities by Spring Creek mine employees and their families. The significance of the increased use would be a probable decrease in the quality of recreational experience rather than a decrease in the available opportunity. This, however, would be difficult to quantify.

The impact of increased use of lands and recreational facilities would include additional maintenance costs for facilities and increased conflict between rural land owners and recreational users. Increased use of facilities would also create additional interaction between users along with increased litter and possible pollution problems at both developed facilities and properties adjacent to the site.

TABLE III-6.--Unit trains per week past crossing[1]

Road crossings	From Spring Creek mine	From East Decker mine	From North Extension mine	From West Decker mine	From all four mines	Time per week crossings would be blocked by trains[2]
County road----	---	25.8	---	---	25.8	1 hr 22 min
Route FAS------	38.4	---	8.8	38.4	85.6	7 hr 51 min
Wyoming Highway 336 near Wyarno---------	([3])	25.8	8.8	38.4	73.0+	6 hr 39 min+

[1]Includes loaded outgoing and empty returning trains.

[2]According to Burlington Northern observations, loaded trains would block crossings an average of about seven minutes; empty trains would block crossings an average of about four minutes, for an average of 5.5 minutes each.

[3]Specific routing and destinations for Spring Creek coal is not known, although 50% of the expected production is committed for use in Pacific Power and Light Co. thermal electric plants.

There would probably be an increase in hunting, poaching, and trespassing as a consequence of the increased population accompanying mining activities (Montana Dept. of Fish & Game, 1977).

Cumulative recreation impacts would include an increased (but unknown) demand leading to overuse, on the existing recreational facilities at Tongue River Reservoir, Custer and Big Horn National Forest, county recreation areas in Sheridan County, Wyoming and city facilities in the town of Sheridan.

N. CULTURAL RESOURCES

Impacts to cultural resources would consist of losses of archeological and historical sites for scientific research, public education, and other values. Losses would result from destruction, disturbance or removal of cultural resources as a result of coal mining activities, unauthorized collecting, and vandalism.

Ninety-three known sites and an undetermined number of unknown sites would be disturbed. In the area to be mined, 53 sites would be destroyed, 40 sites in the peripheral areas may be destroyed or disturbed to an undetermined degree.

A beneficial impact of development would be the gain in knowledge derived as a result of the cultural resource investigations which otherwise may never occur except as a result of mining.

O. ESTHETICS

The greatest impact on esthetic qualities, for the duration of mining, would be the marked change from a rural to an industrial setting. Although most of the mining operations would not be visible from the main road (FAS 314), some of the mine facilities and railroad would be clearly visible. Dust arising from mine operations would probably be one of the most obvious visual impacts.

Odors from vehicle emissions and dust would partially replace natural odors, predominantly the smell of vegetation. Sounds related to mining activities--trucks and trains, drilling, blasting, and coal-handling devices--would pervade the formerly quiet rural area.

Following the period of mining, quiet would return to the Spring Creek mine site, and the visual signs of mining, the facilities, and the railroad would be largely, if not entirely, camouflaged by reclaimed vegetation.

CHAPTER IV: MITIGATING MEASURES

Measures that would be employed to mitigate the adverse impacts of mining are (1) those measures proposed by the company as a part of the mining and reclamation plan (if the plan is approved, the measures are binding on the company); (2) those measures required to meet the standards required by various Federal and State laws and regulations, the principal agencies being outlined in table I-1; and (3) additional requirements or stipulations that could be imposed at the discretion of the Area Mining Supervisor, the Commissioner of the Montana Department of State Lands, or other Federal or State agencies which have permit authority (such requirements must be reasonable and noncapricious). The mitigating measures proposed by the company or required by various laws and regulations are discussed in Chapter I of this statement.

Additional mitigations which could be imposed, at the discretion of permit-issuing agencies, would necessarily be based on need as indicated by the failure or anticipated failure of proposed and required mitigations. Failure of mitigations could be identified through required monitoring and observation during mandatory inspections by the Area Mining Supervisor, USGS; staff personnel, Office of Surface Mining; the District Manager, BLM; Reclamation Division, Montana Department of State Lands; and other responsible State and Federal agencies.

Further measures and standards that could be imposed are discussed as alternatives in Chapter VIII.

CHAPTER V: ADVERSE IMPACTS THAT CANNOT BE AVOIDED IF THE PROPOSALS ARE IMPLEMENTED

Mining would decrease the stability on about 4,420 acres of reclaimed land surface, thus resulting in increased erosion and deposition in the permit area, locally as much as 5 times the present levels. Severe gullying would occur upstream from and on the regraded highwalls along the southern part of the permit area (beginning in about the 20th year of mining), with consequent deposition at the foot of the regraded highwall; about 700 acres would be thus affected. Eroded sediment would not be expected to reach throughflowing streams. Erosion would increase slightly in Spring Creek downstream from the permit area because of a reduced sediment load of the stream exiting the permit area. Both during and after mining, runoff and sediment yield from the permit area would be slightly reduced, although sediment yield would be greatly increased during a 50-year flood during mining. There is a 40-percent probability that such a flood would occur during the 25-year life of the mine. The several-hundred-yard-long perennial reach of South Fork in the southeast corner of the permit area would be eliminated unless declared to be an alluvial valley under the definition of OSM, in which case, regulations could preclude disturbance. Several ephemeral impoundments would be removed from the permit area. Although magnesium sulfate leached from the spoils would slightly reduce ground-water quality in the Anderson-Dietz aquifer east of the permit area, that reduction would probably not conflict with anticipated uses of ground water. The water level in one currently used well (NE1/4 NE1/4 sec. 31, T. 8 S., R. 40 E.) would be lowered, possibly enough to make the well unusable.

Air quality would be degraded by particulates (dust) and emissions of pollutant gases continuing through the life of the mine. It is anticipated that the maximum allowable Montana guidelines and Federal primary standards for 24-hour concentrations of total suspended particulates (TSP) would be exceeded several times a year. Fugitive dust, theoretically amounting to as much as 21,000 tons per year, would adversely affect the growth of vegetation, as well as animals that would feed on that vegetation.

Soils would be destroyed within the permit area and their productivity would be slightly reduced on about 2,200 acres (including facilities location, and associated disturbances) and moderately reduced on about 2,000 acres actually mined. The replaced soils would become increasingly sodic, especially in the eastern half of the permit area. That impact would be severe for about a century. The sodic condition of the soil would further increase the instability of the land surface. A combination of sodic and saline spoils would impede reclamation unless intensive management were undertaken. Saline soils would further impede seed germination rates and seedling establishment on reclaimed areas. Vegetative productivity would thus be slightly to moderately reduced for several decades, especially on the sodic soils in the east half of the permit area and on the aggrading footslopes of the regraded highwall. The vegetative mosaic and species

diversity would be eliminated, probably for about a century, although new mosaic would begin to develop within about 10 to 20 years. Adequate ground cover would probably develop within about 10 years, but it would be more susceptible to drought than native vegetation. Ponderosa pines would probably not reproduce on the disturbed areas; junipers would probably reestablish after about 25 years; and riparian vegetation would not grow along the perennial reach of South Fork if it were disturbed (See discussion above).

The carrying capacity of the permit area would be reduced for all wildlife and greatly reduced for certain species. Specifically, the carrying capacity for antelope and mule deer would be greatly reduced perhaps as far as 25 to 30 miles from the permit area. Small animals would be almost totally eliminated from disturbed areas during mining and would not approach premining populations for at least several decades after disturbance. Rabbit populations would probably not reattain premining levels. Sage grouse populations would be severely reduced on and around the permit area, and sharp-tailed grouse populations also would be reduced. Populations of raptorial birds (great horned owls, kestrels, long-eared owls, and red-tailed hawks) would be displaced from the minesite, although the impacts to these species would be of minor importance within the subregion.

The Spring Creek mine would contribute about 4 percent to the population growth of Sheridan County between 1978 and 1990, negligibly to the population growth of Big Horn County. Thus the mine would significantly contribute to impacts already being felt in Sheridan County and generally contribute to the cumulative impacts of all mining and related activity.

The majority of the fiscal impacts would fall upon Sheridan County and city. Nearly all revenues generated by mining activities at Spring Creek (coal severance tax, property tax, and personal income tax) would go to Montana and Big Horn County. There would be small differences in contributions to Wyoming State revenue (sales tax, property tax, and license fees) associated with the Spring Creek mine. Until available State and Federal grant money is fully utilized by Sheridan County and city, community services would be short of funds to meet demands from the added population due to Spring Creek. Individuals working in the local service sector, and people on fixed incomes, the elderly and the poor, would be most severely affected by economic stimulation and inflation resulting from growth due to Spring Creek. Spring Creek would contribute about 300 students to Sheridan County school districts by the year 1990.

About 7 square miles of land used dominantly for grazing and wildlife habitat would be used, instead, for coal mining and related support facilities for about 25 years. After reclamation, disturbed lands could not, according to the law, be used for agriculture (even if suitable) until native vegetation had first been reestablished and bonding requirements met. About 60 acres of agricultural lands, dominantly in Sheridan County, would be permanently urbanized in response to population growth caused partly by the several hundred employees of the Spring Creek mine.

Traffic would increase moderately on FAS 314 between the mine and Sheridan. Regionally, traffic would increase slightly on I-90, U.S. 87, U.S. 212, and Wyoming 338. Increased rail traffic would hamper local traffic at the existing at-grade crossing south of the West Decker mine. At full production, the Spring Creek mine would account for almost half of the 86 trains per week on the rail spur to the Burlington Northern line at Wyarno. Each train would delay traffic about 5 minutes, although malfunctions would commonly delay traffic for 30 minutes or more.

The perceived quality of recreation would decline, although actual recreation opportunities would probably still be adequate. Dominant impacts would be to outdoor recreation facilities on the Tongue River Reservoir, in Big Horn and Custer National Forests, and to urban recreation facilities in Sheridan and Sheridan County.

Ninety-three known archeological sites (16 of which have been determined eligible for inclusion in the National Register of Historic Places) and an undetermined number of unknown sites would be disturbed. In the area to be mined, 53 sites would be destroyed. 40 sites in the peripheral areas may be destroyed or disturbed to an undetermined degree. Unavoidable destruction, disturbance, and removal of paleontological resources, both exposed and unexposed, would occur.

CHAPTER VI: THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Surface coal mining is not a new industry in southeastern Big Horn County, Montana and Sheridan County, Wyoming. The present rate of coal production in the area is approximately 12 million tons per year. The Spring Creek mine would nearly double the amount of coal being exported; however, the percentage related to Spring Creek would decline as the East Decker mine expands and as other new mines may become established. Within this subregion, it is estimated that there are approximately 10 billion tons of strippable coal reserves (Matson and Blumer, 1973; Lageson and others, 1978). Depending on a continuing market demand for low-sulfur subbituminous coal, it is anticipated that the coal industry will continue to grow. Given the reserves that are estimated, mining could conceivably continue within the local area for a century assuming a production rate of 100 million tons per year.

The proposed short-term use of the Spring Creek permit area is the mining of 243 million tons of coal from an area of about 1,850 acres within a mine permit area of 4,420 acres. Short-term environmental impacts would be important in the areas of social and economic conditions, because of rapid population growth and economic stimulus related to the Spring Creek mine. These impacts resulting directly from Spring would become relatively less severe after the first several years because of assimilation of the new population and because of further growth in the area associated with other projects.

During mining, air quality would be reduced and would probably violate standards about 5 times per year for total suspended particulates (TSP). Land use would change from grazing and wildlife habitat, as soils were progressively disturbed and vegetation removed, ultimately on nearly all of the 4,420-acre permit area.

Long-term environmental costs of mining coal at Spring Creek, by methods proposed in the original company plan, would be caused primarily by the physical disruption of the presently-balance ecosystem--the soils, the vegetation, and the hydrologic regime.

Within a few decades to about a century after abandonment of the mine, the soils and vegetation would probably support essentially the premining land uses at about 80-90 percent of the premining level. The loss of vegetative diversity and vegetation mosaic would be among the impacts of longest duration, with concomitant lag in the development of specialized wildlife habitat, especially for sage grouse.

Introduction of a major change in topography of the reclaimed mine area would cause a disequilibrium in the geomorphic stability of the area. Removal of the alluvium of South Fork would cause permanent destruction of the only spring that now exists within the permit area. Groundwater within the replaced overburden and the Anderson-Dietz aquifer would be permanently reduced in quality.

Archeological and historical sites and artifacts are non-renewable resources. In the event that significant sites are not located during the survey process and are destroyed during mining, the resource loss would be irretrievable. In addition to the possible loss of such a physical resource, educational and scientific information regarding our cultural heritage, would also be lost to both present and future generations.

CHAPTER VII: IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

During the 25-year life of the proposed mine 243 million tons of coal would be removed and utilized for power generation. Mining activities would consume 2.25 million gallons of diesel fuel, 32,000 gallons of gasoline, 50 million kilowatt hours of electricity (assuming two 8-hour shifts, 5 days per week), and 184 acre-feet of ground/surface water (which could not be used until it returns to the hydrologic system), annually. About 1-2 million tons of coal would be dispersed in the replaced spoils and thus would not be available for future recovery. The Canyon coal bed would not be recovered, although anticipated advancements in mining technology would make the bed recoverable in the future. An intermediate amount of clinker and a small amount of gravel would be lost to future use as construction materials within the immediate area. The commitment of clinker and gravel would not be significant because of the great abundance of these resources in the surrounding area. Additional commitment of resources would include both capital expenditures (on mining equipment) and human resources (time and labor). The hydrologic integrity of the Anderson-Deitz aquifer the alluvial aquifer, and the surface water systems, within the mine area, would be destroyed and lost to future use. Topographic relief would be irreversibly altered thus creating a single airshed where two had previously existed. Stream channels flowing over the highwalls would irreversibly alter the erosion and deposition characteristics of the area.

The productive capacity of the soils would be lowered through the disruption of the soils' physical, chemical, and biological characteristics. Alteration of this productive capacity would reduce the vegetative productivity and diversity and would eliminate ponderosa pines and much of the riparian community species as self-sustaining populations. In response to the alteration of vegetative productivity and diversity, the carrying capacity for wildlife would be accordingly reduced, principally for antelope, mule deer, sage grouse and raptors (through a loss of preferential nesting areas).

Social and economic environments may be transformed, although historically areas once developed in association with deep mining in the Sheridan area have reverted to agricultural lands. Suburbanization and commercial development of some lands adjacent to the population centers would be committed and would constitute irreversible land uses.

The sixteen archeological sites that have been nominated for the National Register of Historic Places would be mitigated prior to disturbance; however, additional undiscovered sites of comparable significance may be hidden beneath the surface and could be destroyed by mining.

CHAPTER VIII: ALTERNATIVES TO THE PROPOSED ACTION

Various alternatives to the direct approval of the proposed mine at Spring Creek can be imposed by the Secretary of the Interior and the Montana Commissioner of State Lands when it is deemed necessary to minimize impacts of the proposed mining. Modifications to the mining and reclamation plan must be approved by both the Secretary and the Commissioner. However, because of differences between Federal and State regulatory and approving authorities, course of action and alternatives imposed may be significantly different. The alternatives that apply to the Spring Creek mining proposal include those resulting from the administration of existing regulations of the Federal and State regulatory agencies. The options available to these agencies, as provided by existing legislation, and the resulting impacts of exercising these options are discussed below, as well as technological alternatives to the proposed operation.

A. ADMINISTRATIVE ALTERNATIVES AVAILABLE TO THE SECRETARY OF THE INTERIOR IN RELATION TO FEDERAL LEASES AND MINING AND RECLAMATION PLANS

1. NO ACTION

Pursuant to implied covenants of both the Federal mineral leasing laws and the existing lease agreements, the Secretary is obligated to respond to a legitimate application to conduct mining operations on a valid lease, provided that all terms and conditions thereunder have been met. His response may be approval as proposed, rejection on various legitimate grounds, approval in part and rejection in part, or approval subject to such additional conditions and requirements or modification as he may impose under the laws. He may also defer decision, based on proper grounds, as described elsewhere in this chapter.

"No action" on mining proposal for the initial development of existing Spring Creek lease would equate to maintaining the status quo on those leases. The impacts of taking no action would be the same as described subsequently under subsection 3, "Prevent further development on existing lease."

2. DEFER ACTION

For proper cause, the Secretary may defer final action on this proposed mining and reclamation plan. These could include, but are not limited to, the need and time required for:

1. Modification of the proposal to correct admininstrative or technological deficiencies.

2. Redesign to reduce or avoid environmental impact. Technical alternatives proposed by the company to correct deficiencies in the original plan are analyzed under section VIII-D.

3. Acquisition of additional data to provide an improved basis for technical or environmental evaluation.

4. Further evaluation of the proposal and/or alternatives.

The principal effect of deferring action on a proposed mining and reclamation plan on these grounds would be a comparatively short term delay in the imposition of all related impacts of the proposal as previously described in the unavoidable advers impacts section of this statement.

After a mining and reclamation plan is approved, the regulations and lease terms require that all subsequently proposed departures and deviations therefrom be approved in advance by the USGS. The regulations (30 CFR 211) also permit the USGS to direct that changes be made in previously approved operations. For example, changes could be ordered to accommodate new, improved, or revised administrative requirements, technological improvements, environmental concerns or requirements, or revisions of prior evaluations thereof in the light of experience or unknown factors.

3. PREVENT FURTHER DEVELOPMENT ON THIS LEASE

The only alternatives to allowing development of the existing lease is to prevent such development or to impose additional conditions and restrictions on the operations. The several apparent means of preventing full development are discussed below.

If prevention of further development of the existing lease were accomplished, substantial quantities of coal known to be present would be left in place and not recovered for use. To replace the resources foregone by this alternative course of action, other comparable quantities of coal or sources of energy would be required to meet national needs. The development of other sources and related impacts is discussed later.

a. Suspended Operations

The full development of the existing lease could be delayed by suspension of operations. If such action were taken, there would be no additional incremental environmental impact on the area, and it would continue in its present condition, subject to further modification by natural processes, the continuation of existing mining activity, and such future uses of the surface as the owners may decide.

The authority of the Secretary of the Interior to suspend operations has been utilized on other leases in the past and future

suspensions of operations for reasonable periods, with proper grounds, could be imposed. The Secretary cannot, under present circumstances, suspend operations to the extent that a de facto cancellation of a lease results unless he seeks and obtains additional authority from Congress. Viability of this option is dependent upon timely legislative action; the option of suspending operations pending legislation remains available. Impacts of this alternative would be similar to those described in subsection VIII-3-b, "Cancel the leases."

b. Cancel the Lease (No New Development)

The Secretary does not possess authority to unilaterally cancel the Spring Creek lease except on the grounds defined therein (section 7 or 8 of the lease terms--"Proceedings in case of default"). The authority to cancel on other grounds would require Congressional authorization for such action as well as for the requisite funds for compensation of the lessees as may be necessary. The Administration has not entered a request for such legislation, and the Congress has not initiated such action in the matters considered in this statement. The possibility of such action is a matter for further consideration by the Administration and the Congress in the light of this environmental statement and other relevant non-environmental concerns.

Further development of the existing lease could be interrupted temporarily or terminated completely.

To the extent that coal production from the existing lease was curtailed or halted, alternative sources of energy would be required to meet present needs and demands. These could be foreign and/or domestic and are discussed on later pages. The time rquired to replace the resource foregone could range from scant to a number of years, depending on the specific alternative(s) selected and its state of production.

Environemtnal impacts of the proposals could range widely, depending on the administrative action taken on the existing lease. If this lease was cancelled through Congressional authorization, all physical, esthetic and socioeconomic impacts stemming from the proposed mine would be avoided. Conversely, should development eventually be authorized, environmental impacts as discussed in the impact chapter would occur. The net result would be a deferral and perhaps reduction of impacts through changed technology or requirements imposed at that time.

c. Federal Acquisition of this Lease

The outstanding leasehold interests could be acquired by the Secretary. The ability to acquire the leasehold interests is not granted by the existing relevant statutes and would require Congressional authorization for such action as well as for the requisite funds for compensation of the lessees. To date, the Administration has not requested such action, and the Congress has not initiated or considered

such legislation; the possibility thereof is thus conjectural at best. The major effects of such Congressional authorization would be similar to those of cancellation of the lease as previously discussed under subsection 3 (b).

d. Reject this Mining and Reclamation Plan

Rejection of the proposed mining and reclamation plan would result in no environmental impact on the leased lands, and they would continue in their present condition, subject to modification by natural processes and by the condition of other existing activity and uses--and to further modification by the surface owner to meet other uses.

The Secretary may reject any individual proposed activity that does not meet the prescriptions of applicable law and regulations under his authority, including the potential for environmental impact that could be reduced or avoided by adoption of a significantly different designed course of action by the lessee (operator). Except when a mine plan does not comply with existing regulations, the Secretary cannot under present circumstances reject the proposed plans to the extent that a de facto cancellation of a lease results unless he seeks and obtains additional authority from Congress. Viability of this option is dependent upon timely legislative action; the option of rejecting the proposed plans pending legislation remains available. Impacts of this alternative would be similar to those described under subsection 3 (b), "Cancel the lease."

4. RESTRICT DEVELOPMENT ON THIS LEASE

The subject lease conveys the right to develop, produce, and market the Federal coal resource thereon if all other terms and conditions have been met by the lessee. In general, the Secretary does not possess the authority to arbitrarily constrict development. Various measures that may tend to restrict development may be taken by the Secretary at any time in the interest of conservation of the resources or in the protection of various specific environmental values in accordance with existing laws and regulations; for example, the National Historic Preservation Act of 1966, the Endangered Species Act of 1973, etc.

Thus, under present conditions a general effort to restrict or regulate development of the existing lease for reasons other than failure to comply with existing laws and regulations would constitute a selective application of the "prevent development" alternative already discussed; that decision, as it relates to impacts, possible litigation, and the need for authorizing legislation, would be relevant in this instance.

5. APPROVE THIS MINING PLAN AFTER MODIFICATION

A number of the impacts identified and described in Chapter III of this statement could be more fully mitigated by the selective application of those measures described that are supplemental

to the proposal of the Spring Creek Coal Company or by implementation of one or more of the alternatives described below. Among the more obvious options to be considered are changes in the configuration of the proposed mine area, mining procedures and production rates and coal transportation systems. Such modifications could include any that might be imposed by the State of Montana in its approval process. Under the joint agreement (30 CFR 211) the State advises the Secretary of its decision, and the Secretary subsequently renders his decision on the State approved plan (VIII-B-1). In addition, special conditions could be added to the approved plans relation to the secondary effects of mining. Such conditions must be reasonable and, if unacceptable to the lessee, could result in the lessee not developing the lease areas with the resultant impacts previously discussed under subsection VIII-3-d "Reject the mining and reclamation plans."

6. ALLOW DEVELOPMENT OF SELECTED AREAS NOW UNDER LEASE

This alternative would permit only selective exploration and development of the existing leasehold, based on anticipated adverse environmental consequences. The decisionmaker has the authority and responsibility to evaluate the coal resources and impacts of mining on is lease prior to acting on the proposal. Exploration and development could be allowed only on the leasehold, or portions thereof, that would have the lowest anticipated adverse environmental consequences. Weighing the tradeoffs of mining or precluding mining on selected tracts is part of the evaluation and decision process. Adoption of this alternative would reduce adverse effects by reducing the area in which the impacting activities could take place.

The alternative of allowing the development of only selected areas already under lease constitutes a selective application of the alternative of preventing further development of the existing lease described above. Absent a showing lease-by-lease or plan-by-plan of the likelihood of wholly unacceptable environmental impacts that could not be reduced to an acceptable level, the Secretary does not possess the authority to otherwise constrain development of the leasehold if all other requirements of the lease have been met. In addition, application of this alternative would thus be contrary to principles of conservation embodied in the legislation which authorizes the leasing of these lands for the purposes described. It is entirely possible that such selective mining would leave isolated blocks of coal that might never be recovered owing to the high costs of mining such remnant areas at a later date.

B. ADMINISTRATIVE ALTERNATIVES AVAILABLE TO STATE AGENCIES

1. DEPARTMENT OF STATE LANDS

The authority for State action regarding mining and reclamation rests with three laws:

(1) Montana Strip and Underground Mine Reclamation Act
(2) Montana Strip Mine Siting Act
(3) Montana Strip-Mined Coal Conservation Act

The State does not have an equivalent to the Federal "no action" alternative. If, in fact, no action were taken by the Department within 240 days after receipt of a complete application for a mining and reclamation permit, the permit would be statutorily approved, by default.

The State also does not have a formal administrative alternative to "defer action" following the receipt of a completed application for a mine and reclamation permit. However, the State may deem an application incomplete due to failure of the mine and reclamation plan to meet State requirements, leading to a postponement of the action, which has the effect of deferral.

Other than the decisions to approve or disapprove a permit, only two viable alternatives are open to the State: (1) approval of the permit with modification; and (2) selective denial of the permit to mine in a specified area that includes lands having special, exceptional, critical, or unique characteristics, or where mining would affect the use, enjoyment, or fundamental character of neighboring land having the above special characteristics. Either or both of these alternatives, which could be legally invoked after the permit application was deemed complete, would generally be exercised by the Department during its review of the application, thereby making modification and/or selective denial prerequisite to the acceptance of a completed application. The State plays a larger role than the Federal government in the process of planning before action is required on specific mine and reclamation permits.

Impacts that would result from rejection of the Spring Creek permit application would be the same as those discussed under the Federal administrative alternative of preventing development of the existing lease. Impacts that would result from approval of the permit are those analyzed in Chapter III. Impacts that would result from modification of the permit application, or from selective denial of the permit to mine in certain areas, are similar to those discussed under Administrative Alternatives available to the Secretary of Interior.

2. DEPARTMENT OF HEALTH AND ENVIRONMENTAL SCIENCES

The Montana Clean Air Act is the law under which the Department of Health and Environmental Sciences would exercise its authority to take action on the application for a permit to construct and operate coal-handling facilities at Spring Creek. Such action would pertain to the designs for constructing coal-crushing, storage, and loadout structures, and to the operation of coal-handling facilities after construction, in order to insure that the best possible control technology would be applied toward preventing and abating air pollution.

Three administrative alternatives open to the Department are disapproval, approval, or approval after acceptable modification of the construction and/or operating designs.

Decisions of the Department of Health and Environmental Sciences are not contingent on those of the Department of State Lands, with the result that disapproval by either Agency would cause rejection of the entire project. The impacts due to disapproval of the permit for coal-handling facilities would therefore be the same as those from rejection of the mine and reclamation permit. Impacts due to approval of the coal-handling facilities are those analyzed in Chapter III. Impacts that would result from modification of the designs for construction and/or operation of coal-handling facilities are discussed under Technical Alternatives.

3. DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

Under the Montana Act, and by agreement with the U.S. Bureau of Land Management, the Montana Department of Natural Resources and Conservation has authority to take action on the permit application for the railroad access corridor to Spring Creek. For other permitting responsibilities by the State and Federal agencies, (see table I-1).

C. TECHNICAL ALTERNATIVES

Alternatives to the proposed mine and reclamation plan that would entail different configurations of the mine area, different procedures for mining or reclamation, different rates of production, or different coal transportation systems are considered to be technical in nature. These alternatives would affect the construction and operation of the proposed Spring Creek mine, and the various alternatives could produce different environmental impacts.

1. CONFIGURATION OF THE PROPOSED MINE AREA

The proposed mine area was selected to obtain the maximum recovery of a nonrenewable fuel resource consistent with reclamation of the land and protection of other resources. Restriction of the size or shape of the area to be mined within the permit boundary might actually increase several of the adverse environmental impacts in the presently proposed area.

The amount of reduction in the number of acres to be mined within the permit boundary would be limited for both economic and environmental reasons. Economically, each acre of coal left unmined would represent approximately 142,000 tons (assuming a thickness of 81 feet and a bulk density of about 1,750 tons per acre-foot). The valleys of both Spring Creek and South Fork Spring Creek are economically most attractive for mining because the overburden is thinnest there;

however, if 81 feet of coal were removed from only beneath the valleys there would not be enough spoils to fill the pits. To leave depressions after mining would be unacceptable by environmental standards. The Company proposes to use overburden, obtained from the ridge between Spring Creek and South Fork, to fill the void left by removal of the coal. To mine only the central bluffs area would be economically unattractive; and it would not be possible to dispose of the large amount of spoil material, resulting from the removal of 240 feet of overburden, in a way acceptable by present standards.

2. MINING PROCEDURES

Different procedures could be required for removing topsoil overburden, and coal if the procedures as proposed were considered technically inadequate, unsafe, or likely to result in unacceptable environmental consequences. The methods proposed in the mining plan are those currently in use at other existing mines in southeastern Montana and Wyoming. These procedures are used at other large strip mines in the West and are generally accepted as being the safest, least wasteful and most technically and economically feasible for this type of operation.

It is difficult to envision any reasonable alternatives to the Company's proposal to mine by dragline in combination with trucks and shovels, unless it would be to omit the dragline and use only trucks and shovels. Environmental impacts that would result from using trucks and shovels only would be expected to differ very little from those that would result from the proposal outlined in Chapter I and analyzed in Chapter III. Additional impacts would result, however, from the increased number of trucks and shovels required; the increased traffic on haul roads for which dust suppression would be required; an increase in the number of employees to operate equipment; and an increase in the amount of water required for mine and plant use.

One advantage of using trucks and shovels would be the capability to mine deeper than would be feasible with the dragline, enabling possible recovery of the Canyon Coal seam, 106 feet below the Anderson-Dietz. The 19-foot-thick Canyon seam would add approximately 55 million tons to the recoverable reserves within the lease area.

Underground mining is not considered a viable alternative inasmuch it is not ecnomically competitive, it is wasteful and dangerous and the long term prospect of subsidence of the land surface is not acceptable.

3. COAL PRODUCTION RATES

Under terms of the lease and existing regulations, the Secretary of Interior lacks the authority to regulate production, *per se*, from the

leasehold. However, on environmental or other adequate grounds, some degree of controlled production rates could be effected.

The proposed mining plan calls for a production rate of 10 million tons per year by 1982. A lower mining rate would result in less land being disturbed at any one time and thus a lesser environmental impact each year. However, to produce the same total amount of coal from the lease, the duration of impact would be extended. Less production would also mean reduced employment and annual royalty income to the U. S. Treasury and less tax revenue to Federal, State and local governments.

Increasing the rate of production would result in an accelerated rate of land disturbance, higher employment levels, additional vehicle and rail traffic in the area, and an acceleration in the rate of environmental impacts previously discussed. There would also be larger annual royalty payments to the Federal Treasury, higher payrolls, and increased tax revenues if production was incrased. The total duration of impacts would be shortened accordingly.

4. COAL TRANSPORTATION SYSTEM

If the U.S. Congress grants the pipeline companies the right of eminent domain for in acquiring rights-of-way for pipelines, slurry pipeline may become a vaiable and competitive alternative to rail transportation of coal to market.

To date, several slurry pipelines have been used successfully to transport crushed coal, iron ore, and other minerals over appreciable distances. An example is the 275-mile-long Peabody Coal Company pipeline in Arizona. Slurry pipelines, like pipelines used for transporting oil and gas are underground and except for pumping and storage facilities are not visable at the surface. Dust, noise, and traffic danger resulting from the transportation of an equivalent amount of coal by rail transportation, thereby would be eliminated. Approximately 700 acre-feet of water are required per million tons of coal transported or an equivalent of about 10 cubic feet per second at a production rate of 10 million tons per year when the mine reaches full production. Although this amount of water could be readily developed from local or imported source, the use of water for slurry transportation would involve numerous political, legal and public decisions requiring a lengthy period for resolution.

D. TECHNICAL ALTERNATIVES PROPOSED BY THE COMPANY

1. Highwall Reduction

In response to the January 12, 1978 letter from the Montana Department of State Lands to the Company outlining deficiencies in the

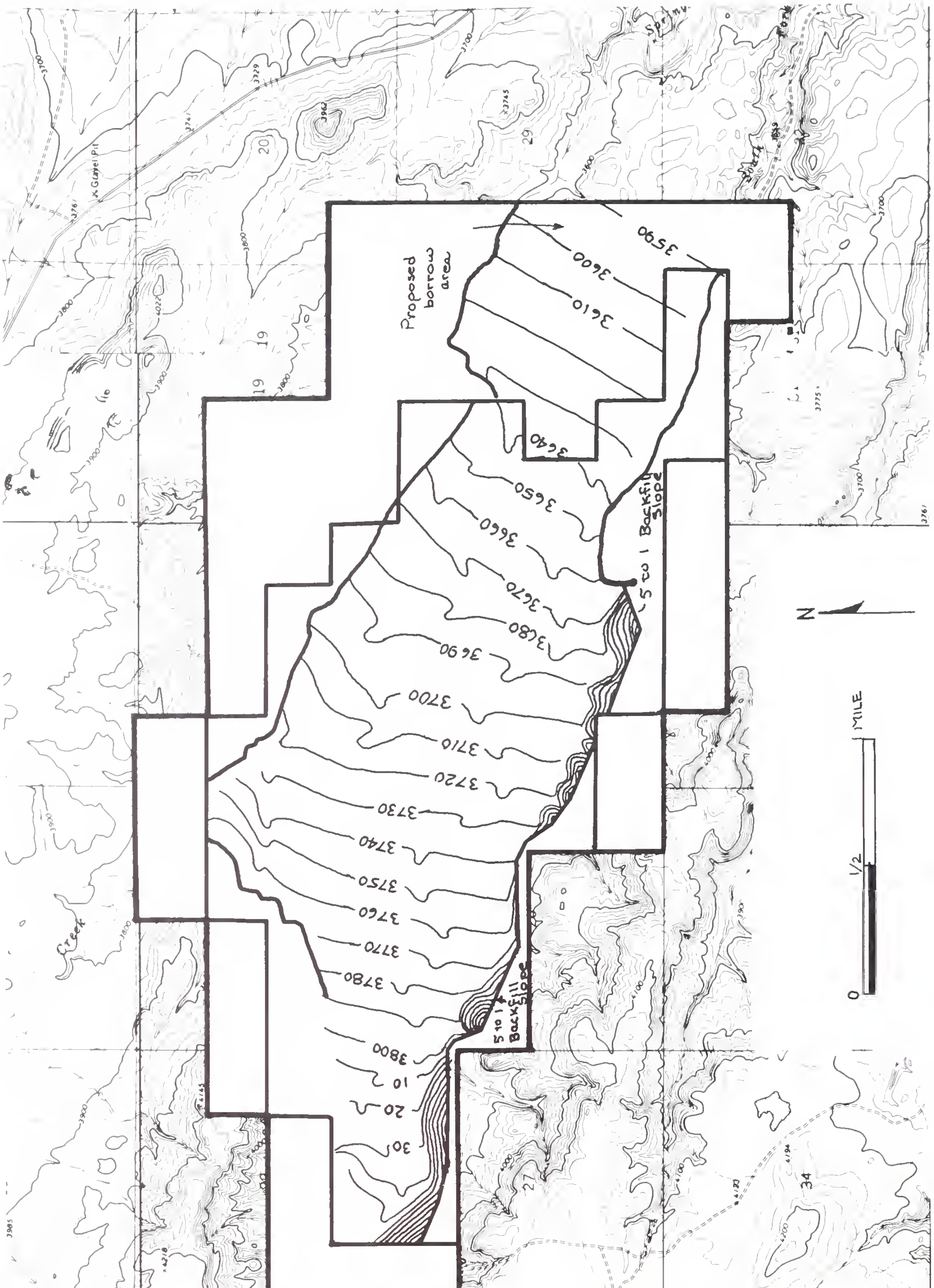

FIGURE VIII-1.--Case 1 - Highwall reduction.

original mine plan, the Company presented a preliminary alternative plan for reducing highwalls along the original mine plan's southern boundary. The plan proposes to reduce the highwalls by backfilling them with overburden materials "borrowed" from an area east of and adjacent to the mining area as opposed to backcutting into the steep, undisturbed terrain south of the mining area. This plan consists of three versions (cases). In each case, presented below, the location of the borrow area and the extent of the disturbance are the same. Although in none of the cases is all the available material in the 508-acre "borrow" area used, the size of the "borrow" area was determined on the basis of the maximum amount of material needed to reduce all highwalls (i.e. southern and western).

Implementation of the backfilling plan would require an extension of the permit bonding area by about 2,000 feet to the east and upgrading the bonding from associated disturbance to mining-level disturbance. The reclaimed topography of the "borrow" area would create a continuation of the east-west trending plain between the channels of Spring Creek and South Fork.

a. Case 1 (fig. VIII-1)

This case assumes mining to the limits of the original mine plan. The highwall created along the southern boundary would be completely backfilled, starting at the crest and sloped into the contour of the reclaimed mining area at a 5:1 (20 percent) gradient. Although the proposed borrow area is 508 acres, only 61 percent (310 acres) of the borrow area would have to be disturbed to obtain sufficient material to backfill the highwall. Within the proposed borrow area 94 acres would have been disturbed by the "clinker" pit and 145 acres would not have to be disturbed by backcutting the highwall under the original proposal. Therefore, 71 acres of increased disturbance would be necessary beyond that in the original mine and reclamation plan.

b. Case 2 (fig. VIII-2)

As with Case 1, Case 2 proposes mining to the limits of the original mine plan and backfilling the southern boundary highwall to a 5:1 slope. However, this case proposes to leave portions of the highwall intact for wildlife habitat and for esthetic reasons. Under this case, 50 percent of the borrow area material would be needed for backfilling. This would result in increased disturbance of 15 acres in addition to the area disturbed under the original mine plan. Leaving highwalls ungraded is contrary to the Surface Mining Control and Reclamation Act of 1977, the rules and regulations pursuant to that Act, and the emergency rules and regulations pursuant to the Montana Strip and Underground Mine Reclamation Act of 1973. Although there is a provision for alternative grading under the Montana law which might allow leaving highwalls, there is no such provision under the federal law.

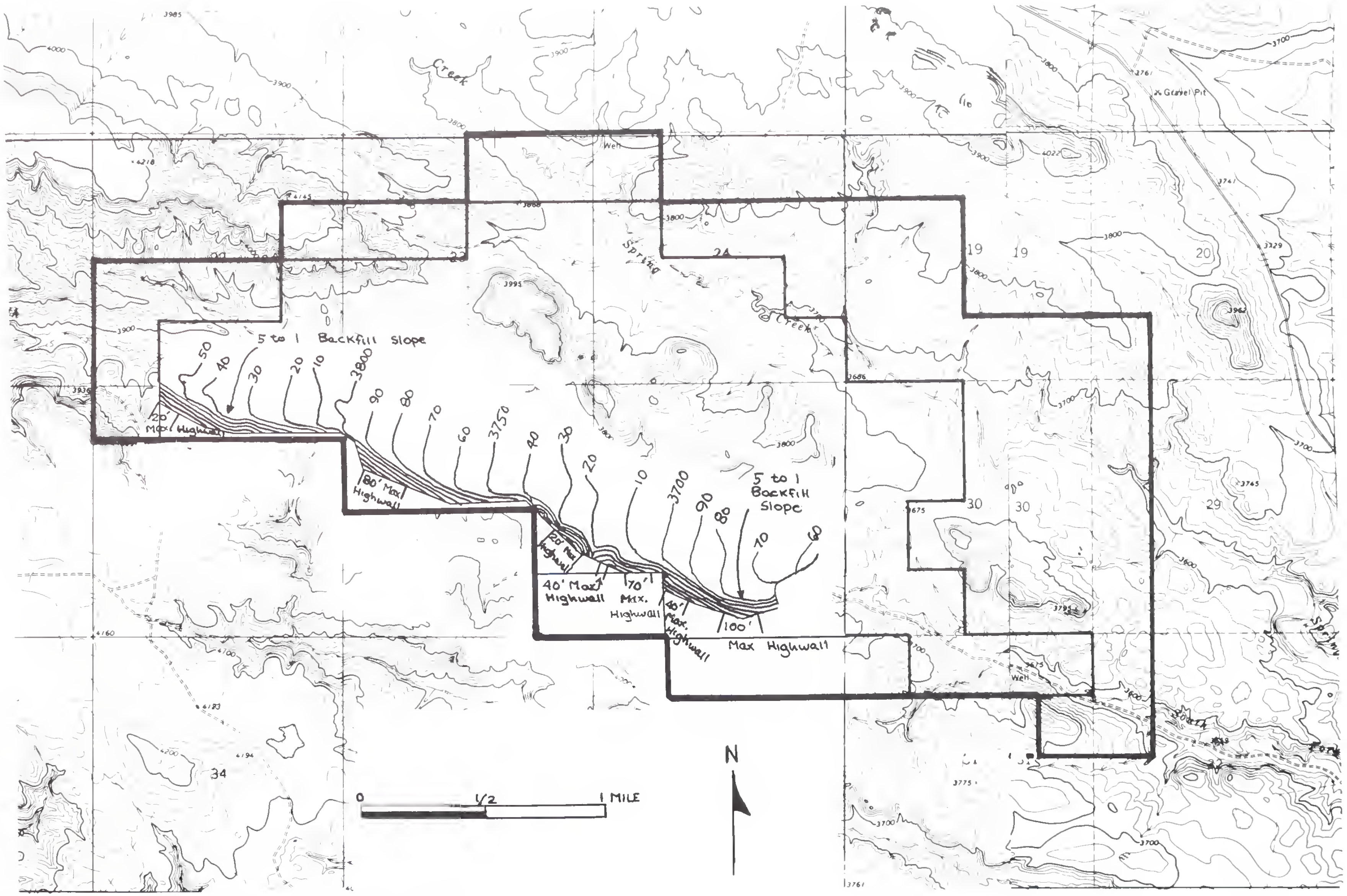

FIGURE VIII-2.--Case 2 - Highwall reduction.

c. Case 3 (fig. VIII-3)

Under this case, the southern mining limit has been moved to the north, avoiding disturbance to the steeper slopes along the southern mining boundary. By retracting the mining limit, 5.4 million tons of recoverable coal would be eliminated from the 243 million tons retrievable under the original mine plan and 39 fewer acres would be disturbed by moving the mining limits to the north. As with Cases 1 and 2, the highwall along the southern boundary would be reduced by backfilling to a 5:1 slope. About 42 percent (213 acres) of the 508 acre borrow area would have to be disturbed to gain sufficient material to backfill the highwall. The result of implementing Case 3 would be the disturbance of 65 fewer acres than under the original mine plan.

d. Impacts from the proposed highwall reductions

Impacts associated with the highwall reductions would primarily involve geomorphology, vegetation, and wildlife. Other disciplines in the physical environment (hydrology, soils, climate and air quality) would be insignificantly changed from those impacts forecast in Chapter III.

Highwall Reduction Cases 1, 2, and 3 would be subject to much the same erosion and sedimentation problems as the regraded highwalls proposed in the original mine plan. The backfilled highwalls would intercept the drainages of several ephmeral tributaries to South Fork Spring Creek. Because no attempt would be made to intergrate these drainages with the reclaimed channel of South Fork Spring Creek, these drainages would be subject to erosion that would spread headward off the permit area. As in the original plan, approximately 700 acres south of South Fork Spring Creek would be affected. Excess sediment produced by this erosion would be deposited upon the sloping plane of the reclamation surface, hindering revegetation attempts.

In all three cases, backfilled slopes would be subject to sheet wash, rill, and gully erosion. The severity of the erosion is related to slope length. Case 1, which would have the longest backfilled slopes, would be subject to the most severe erosion. Case 3 would have the shortest slope lengths, and would be the least susceptible to erosion. Case 2 would have an intermediate susceptibility to erosion.

Case 2 differs from the other two cases in that it proposes to leave portions of highwall. This highwall would form cliffs, and would closely resemble the natural topography. These rock cliffs would have high erosion rates similar to natural cliffs in the area.

Impacts to vegetation arising from the increased disturbance in cases 1 and 2 would be completely offset by avoiding the disturbance of the ponderosa pine and breaks vegetation along the southern mining

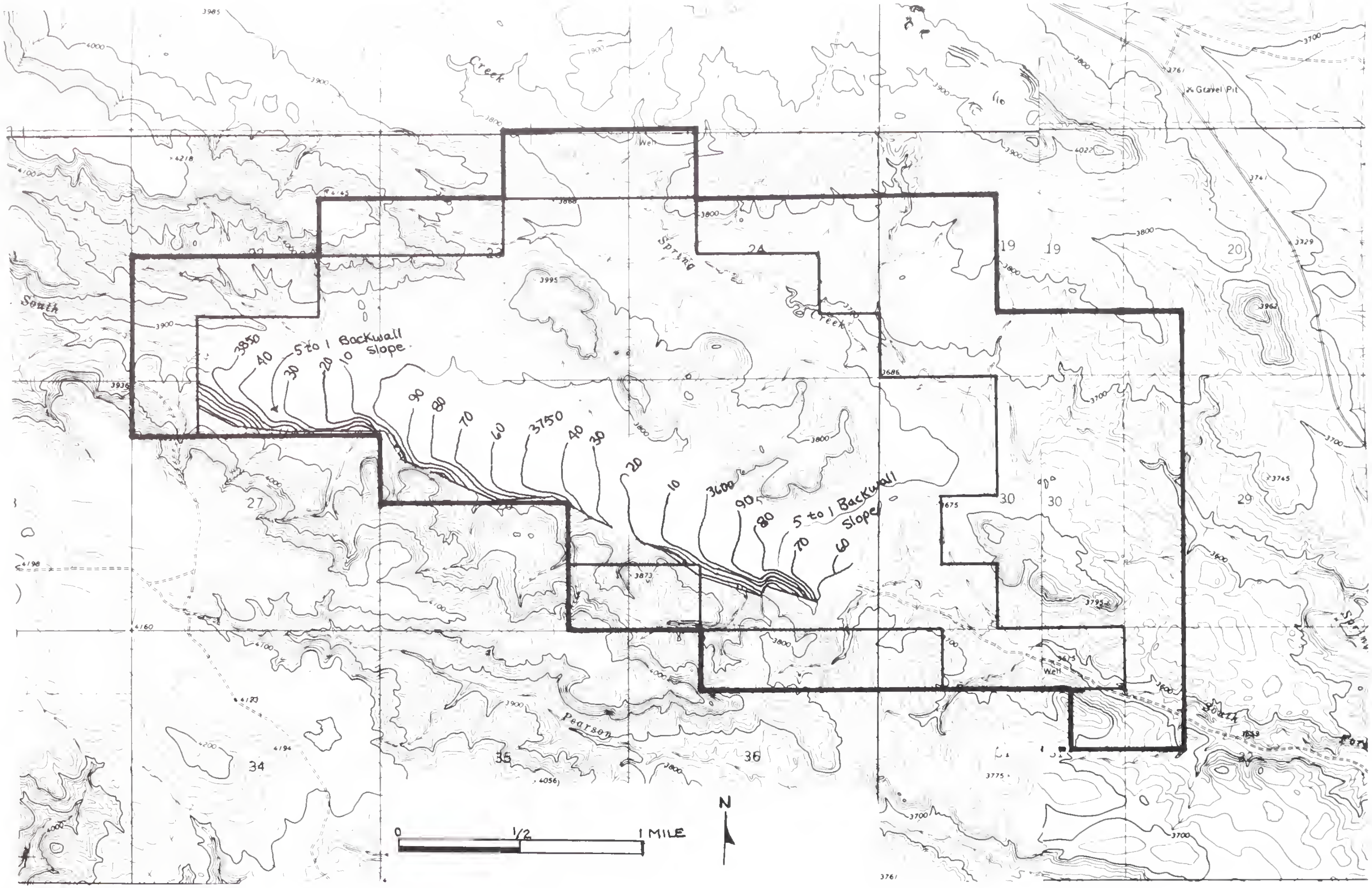

FIGURE VIII-3.--Case 3 - Highwall reduction.

boundary

Impacts associated with increased disturbance within the borrow area, for all three alternatives, would insignificantly alter the impact analysis in Chapter III for wildlife. In cases 1 and 2, 145 fewer acres of wildlife habitat including ponderosa pine/juniper would be disturbed along the southern portion of the mine area. Under case 2, standing portions of highwalls would create potential cliff habitat for wildlife. In case 3, an additional 39 acres of generally steep terrain and important wildlife habitat would be left undisturbed in the southern portion of the mine area. Under all three cases, impacts to wildlife would be somewhat reduced; principally impacts to mule deer and small mammals.

E. Alternate Mining Plan - Central Field Mine Plan

1. Background

In April, 1978, NERCO Inc., Pacific Power & Light Company's subsidiary, submitted a preliminary alternate mining and reclamation plan to the Montana Department of State Lands. The Company is considering modifying its present mining plans to eliminate disturbance of those areas which might be interpreted to meet the definition of "alluvial valley floors" in the Surface Mining Control and Reclamation Act of 1977 or which might be subject to selective denial under the Montana Strip and Underground Mining Act of 1973. This alternate plan (Central Field Mine Plan) was in response to the Department's letter of January 12, 1977, which outlined deficiencies in the original mine plan and indicated concerns of the Department (Appendix Q).

As a result of the lack of definitive criteria regarding alluvial valley floors, the Company feels it would be difficult to meet current permit application requirements at the present time. In addition to the "alluvial valley floor" question, a number of other issues were raised by the Department of State Lands many of which may require additional research programs to adequately address the Department's concerns. Therefore, the Company anticipates gaining timely approval of a mining plan in order to meet commitments for the delivery of Spring Creek coal by avoiding those areas of concern.

Although the Company has not made an offical submittal to the U.S. Geological Survey or the Montana Department of State Lands, the preliminary plans were submitted for inclusion in this statement. The principal differences between the alternate mine plan and the original are in the amount of coal to be mined, the area of disturbance, and the reclamation of the area.

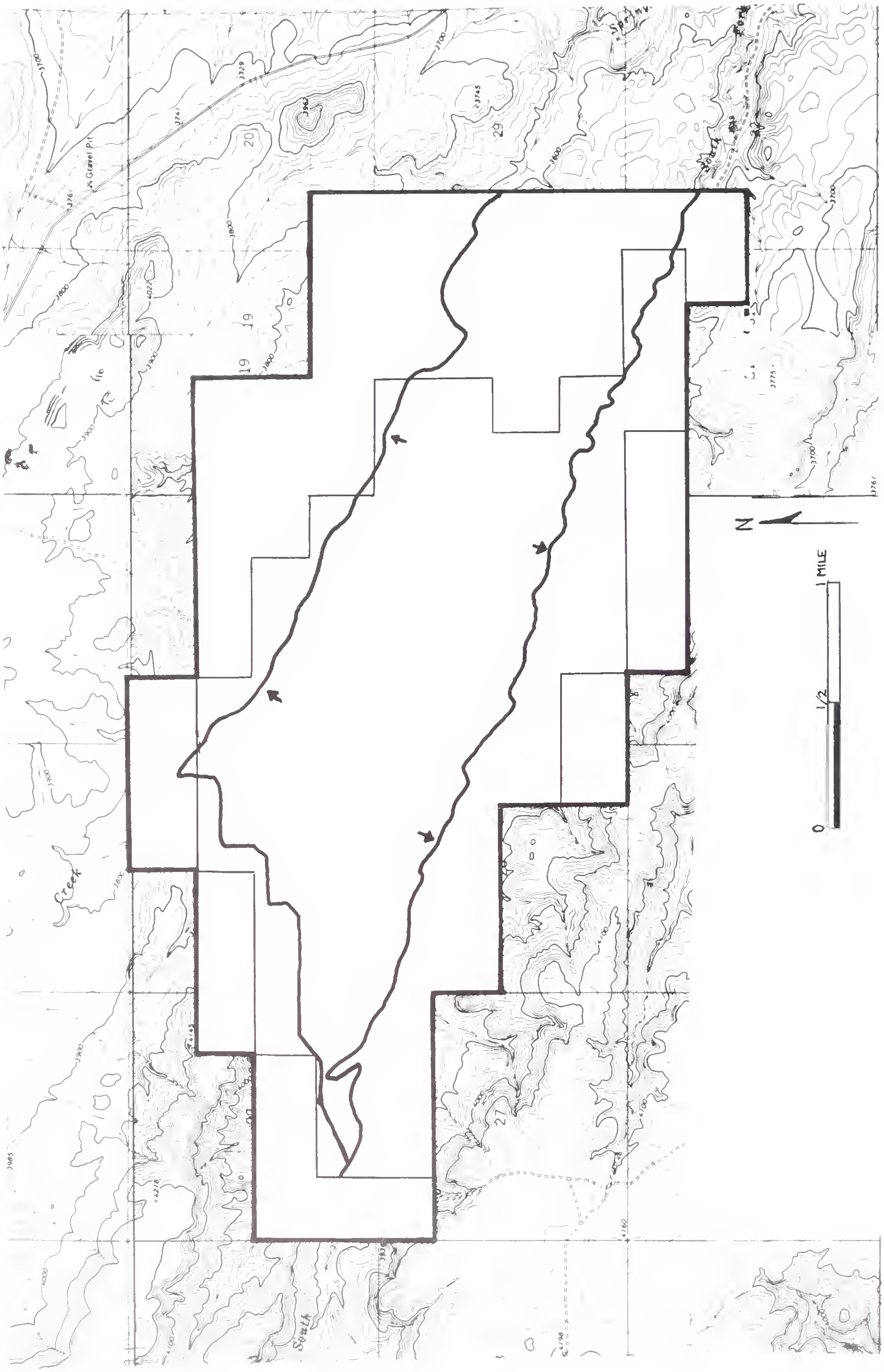

FIGURE VIII-4.--Proposed limit of mining disturbance.

2. Proposals of the Spring Creek Coal Company.

In accordance with the Central Field Mine Plan (the alternate mine plan now being considered by the Company) coal recovery would be confined to the central area of U.S. BLM Lease M-069782. This area is bounded on the north by a line about 150 feet south of the limits of alluvial materials in the Spring Creek channel and bounded on the south by a line about 150 feet north of the limits of alluvial materials in the South Fork Spring Creek channel (fig. VIII-4). Mining plans anticipate the recovery of about 184 million tons of coal from the area; a reduction of about 63 million tons from the 243 million tons recoverable under the original mine plan. Production from the mine would be 2 million tons the first year, 6 million tons the second year, and 7 million tons per year thereafter.

a. Construction of facilities

Mine facilities described in Chapter I would not be changed; however, coal handling facilities would operate at less than the design capacity of 40,000 tons per day. Average daily production of the mine and crushing facilities would be 28,000 tons per day based on a 250-day operating schedule. About 700 acres would be disturbed by the construction of the facilities as compared to 870 acres disturbed by the construction of facilities under the original mine plan. The reduced amount of disturbed area is primarily a result of a reduction in the area required for settling impoundments.

Two minor diversions would be required on Spring Creek during the construction of the facilities. These diversions would have a 14-foot wide bottom, be 7.5 feet in depth, and have 2-to-1 side slopes. The bottom of the diversions would be lined with 1 foot of clinker or the diversions would be constructed in clinker. Because mining would not impinge upon South Fork, no diversions would be necessary.

In addition to the stream diversions on Spring Creek, three drainage ditches would be constructed to intercept runoff from within the mine area. Runoff from the mine area would be intercepted by the ditches and channeled into a settling impoundment east of the "scoria pit" (fig. VIII-5). The ditches would have an 8-foot wide bottom and side slopes of 3-to-1 (33 percent): the ditches would be a minimum of 3 feet deep (fig. VIII-6). The settling impoundment dam would be built to the same specifications as those discussed in Chapter I: the dam would be about 35 feet high. The capacity of the impoundment would be about 125 acre-feet.

b. Mining

During the initial stages of mining two box cuts would be excavated. One box cut would be opened in the northeast corner of the coal field by a truck and shovel operation. The excavation of this box

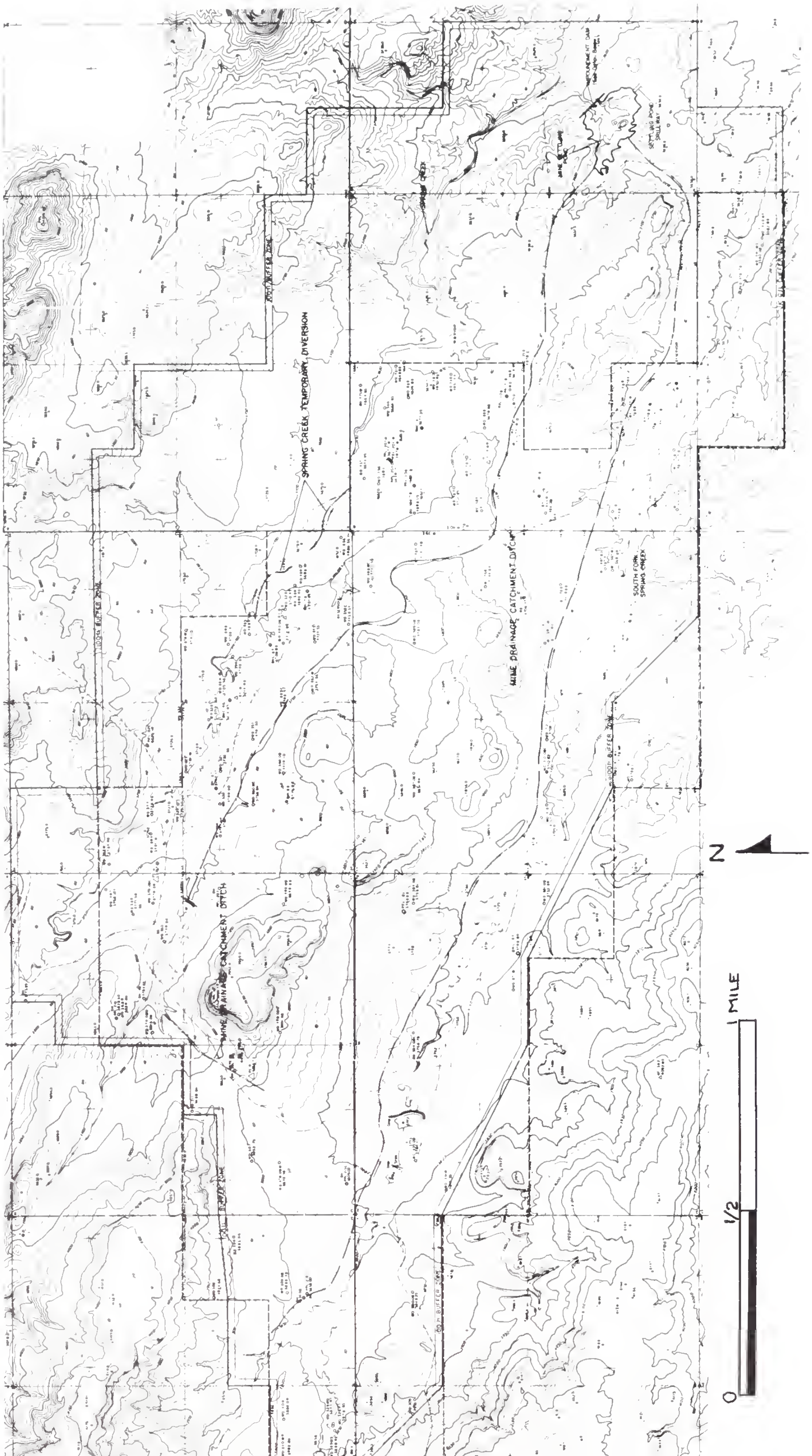

FIGURE VIII-5.--Mining drainage plan map.

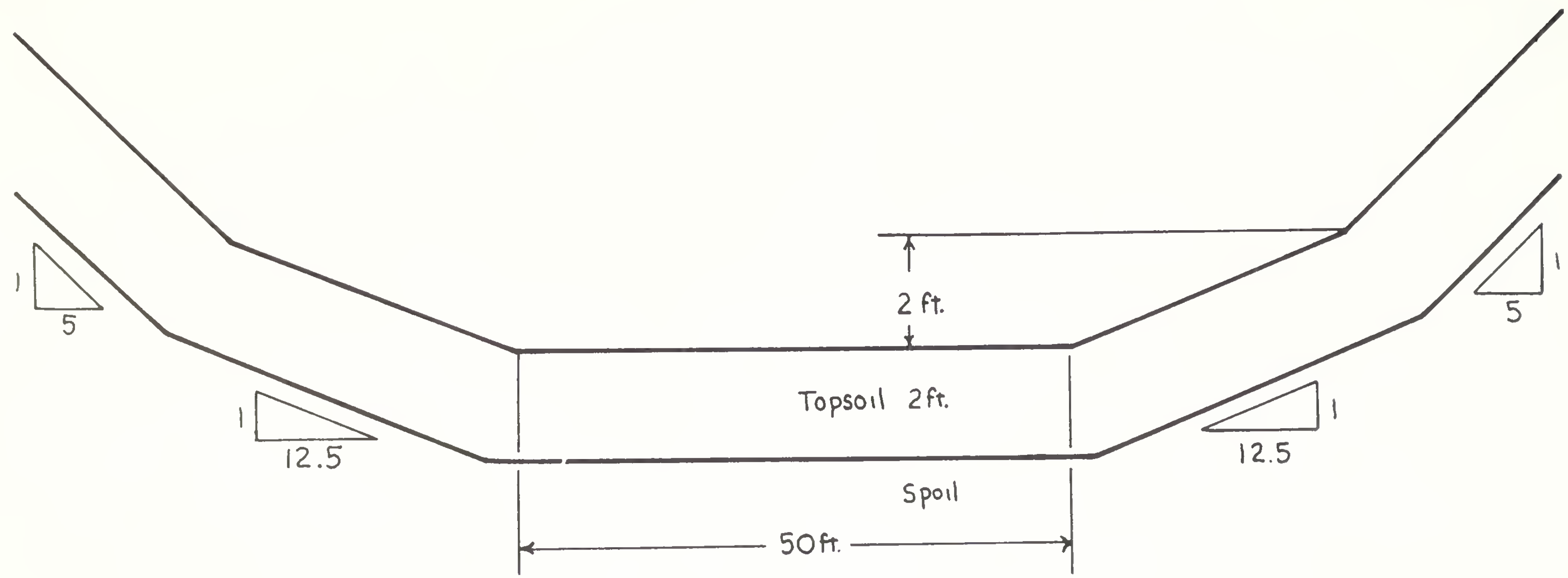

FIGURE VIII-6.--Drainage ditch cross section.

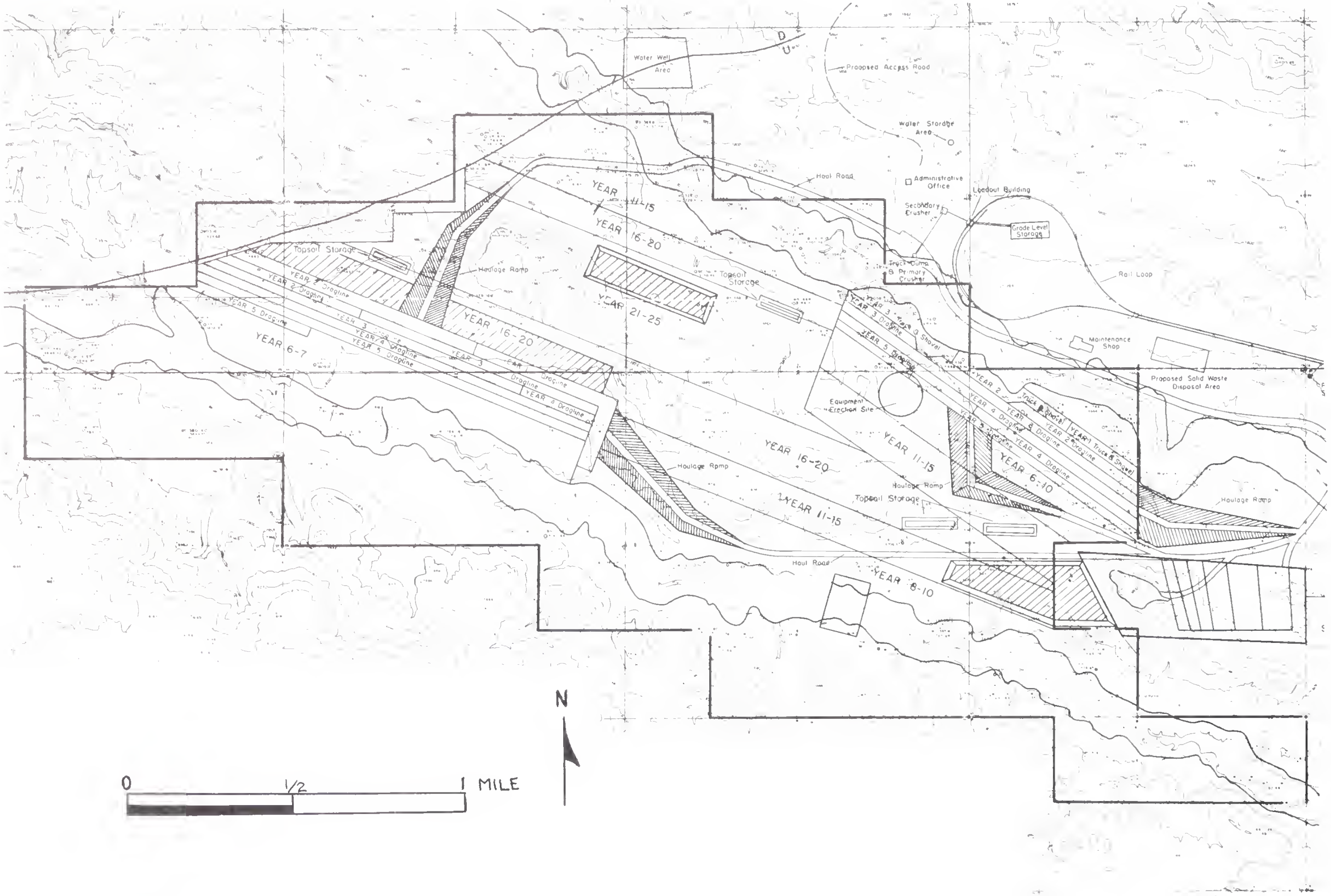

FIGURE VIII-7.--Mine facilities and mining sequence.

cut along the alluvial deposits of Spring Creek, would require about three years. Overburden from this box cut would be stockpiled at two locations, one area south of the box cut and east of the "scoria pit," the other area west of the box cut (fig. VIII-7). The second box cut would be opened in the southwestern part of the field by a dragline. Spoil material from this operation would be cast to the north of the pit on land from which topsoil material had been previously salvaged. The excavation of this pit would take about one and one-half years to complete.

Upon the completion of stripping operations in the southwestern pit, the dragline would be "walked" to the northeast pit to initiate a second cut (turnover cut), casting the spoil material into the previously mined-out box cut. When the dragline has completed the turnover cut in the northeastern area, it would be "walked" to the southwestern pit and perform another turnover cut. The dragline would alternate between the northeastern and southwestern areas, making successive cuts and casting the spoil material into the previously mined-out areas. Upon completion of its box cut, the truck and shovel fleet would begin stripping the high overburden (above the 120-foot cover line) of the central bluff area in advance of the dragline. Spoil material stripped by the truck and shovel fleet would be transported to areas which have insufficient spoil materials to achieve the proposed reclaimed contours. When mining has advanced three or four panels, stockpiled overburden from the northeast box cut would be distributed over the graded dragline spoils, before redistribution of topsoil material. Therefore, reclamation of areas disturbed by mining would not commence until about year four or five of the operation.

Two active pits would be maintained throughout the life of the mine in order to provide operation flexibility and equalization of stripping ratios. During the first five years of mining, about 220 acres would be disturbed by coal mining and an additional 706 acres by associated mining disturbance, including 20-30 acres by quarrying of clinker. About 700 acres would be disturbed by facilities and although about 1900 acres would be bonded for associated disturbance, only about 1,200 acres would actually be disturbed. The area south of the southern mining limit would not be disturbed but would be studied by the company in order to address concerns raised by the Montana Department of State Lands in its evaluation of the original mine plan. Mining would disturb about 40-60 acres per year within the 3672 acre permit area and would ultimately disturb about 1,400 acres (fig. VIII-8). Should the "alluvial valley floor" question be resolved by the determination that Spring Creek and South Fork Spring Creek would not be defined as alluvial valleys within the coal lease area, the Company would strive to gain a permit allowing them to revert to the original mine plan boundaries and production schedule.

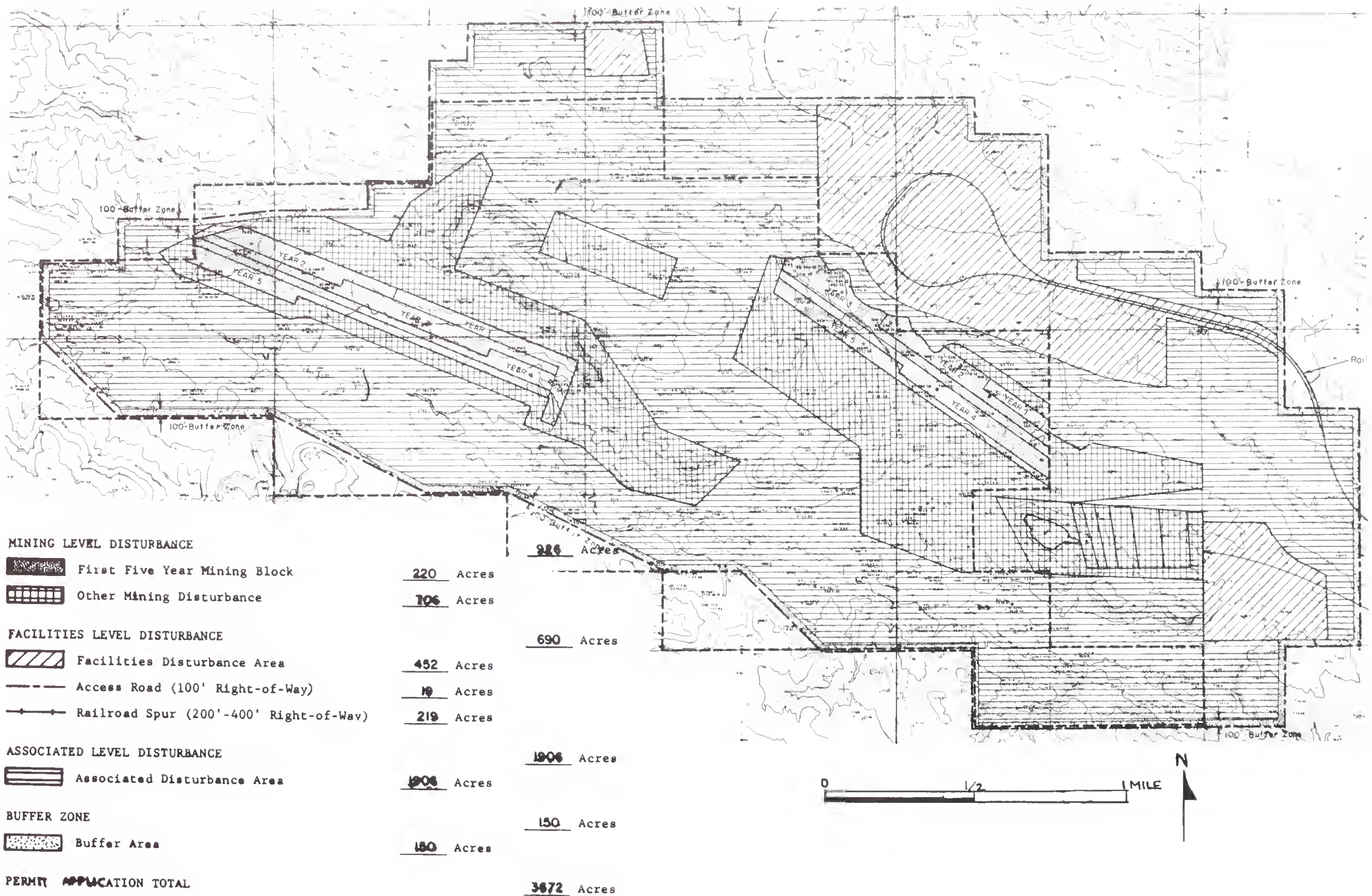

FIGURE VIII-8.--State bonding level map.

c. Reclamation

As with the original mine plan, the Central Field Mine Plan would result in the reduction of the central bluff area to a nearly flat plain with a gentle slope to the southeast. A stream channel would be established in the central portion of the plain and enter Spring Creek at the eastern boundary of the mine area (fig. VIII-9). The reclaimed channel would have a 50 foot wide bottom, would be 5 feet deep and would be 130 feet wide at the top. Side slopes of the channel would be 12.5-to-1 for the bottom 2 feet and 5-to-1 for the top 3 feet (fig. VIII-10).

Highwalls created along the western boundary of the mine area would be backfilled with spoil material from the central bluff area at a grade of 5-to-1 (20 percent). The back filling of the highwalls would not require any additional material as would be necessary to backfill highwalls under the original mine plan (section VIII-D-1).

Topsoil material would be salvaged in a double-lift operation and would be directly replaced on the regraded spoil surfaces, avoiding stockpiling insofar as possible. Because of the 4-to-5 year lag between the excavation of the box cuts and the initiation of reclamation, topsoil materials salvaged during this time would have to be stockpiled.

The Company has not provided any additional mitigatory measures.

d. Equipment and employment requirements

Mining equipment requirements would not be substantially changed (table VIII-1); however, the number of operating shifts for overburden removal equipment and coal production equipment would be reduced to accomodate the reduced production schedule. Because of the reduction in operation shifts, operating manpower requirements would be reduced to 218 employees at full production (table VIII-2). Construction employment requirements would be unchanged: a peak force of 480 employees in April or May, 1979.

3. Description of the environment

The existing environment in the Spring Creek area is described in Chapter II.

4. Environmental impacts of the proposal

a. Geology

Implementation of the Central Field Mine Plan would reduce or eliminate many of the erosion and sedimentation problems identified

FIGURE VIII-9.--Postmining reclaimed topography.

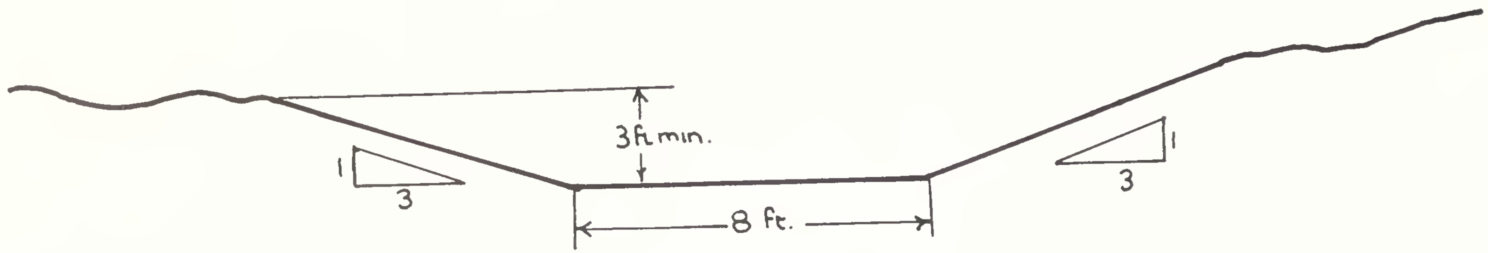

FIGURE VIII-10.--Reclaimed stream channel cross section.

in the original mine plan. The most severe problems in the original plan were associated with creation of a regraded highwall south of South Fork Spring Creek; the Central Field Mine Plan would not disturb that area. The reclaimed surface would still be subject to long-term instability but this instability would be far less limiting to reclamation and future land use. Distinction of the stratigraphic sequence would still affect ground water, soils, and vegetation, but the area affected would be reduced.

(1) Topography and Geomorphology

During mining, disruption of the surface by men and machinery would cause an unknown amount of accelerated erosion. Drainage ditches would intercept most of the surface water and excess sediment, and route this sediment and water to a settling pond on the east side of the permit area. The drainage ditches would be less effective in preventing water and sediment from entering active mine pits, particularly south of the central bluffs.

Water released from the settling pond to the natural drainage would be sediment deficient compared to natural stormflow. Sediment deficient runoff would cut into the channel floor to obtain a natural sediment load, resulting in stream incision. Stream incision below the mine site might locally oversteepen the stream and initiate gullying. Once started, gullying could spread upstream onto the minesite or along Spring Creek.

The impact of removing most of the sediment load depends upon the length of time that the settling pond remains in use, the frequency and magnitude of runoff events, and the amount of mine pit water routed through the settling pond. The impact to the Spring Creek channel would be minimal unless a major storm event occurs during the life of the mine. The probability of a 50-year event or larger occurring at least once during the life of the mine is 40 percent.

The design adequacy and stability of the drainage ditches is unknown. This information will be provided by the company at a later time.

Under this mine plan, no major diversions of Spring Creek or South Fork Spring Creek are proposed. The problem of increased erosion associated with diversions proposed in the original mine plan would be eliminated.

Under the new reclamation plan, the reclaimed surface would remain a broad, gentle, southeasterly sloping plane, and it would be susceptible to wind erosion unless vegetation were quickly reestablished. Local depressions would still collect surface water and sediment, and these depressions might be susceptible to susbidence or salt accumulations. The addition of the reclaimed stream channel would provide more

efficient drainage for the central portion of the reclaimed surface.

Under this mine plan, the area south of South Fork Spring Creek would not be disturbed, and the area of regraded highwall would be reduced to the northwest boundary of the permit area. Regraded highwalls in this area would be susceptible to severe rilling and gully erosion, but because this highwall would interrupt few tributary drainages, erosion upstream from the permit area and consequent on site deposition of sediment would be greatly reduced over that of the original mine plan. Erosion along the major tributary crossing the high wall depends primarily upon stability of the transformation from tributary to reclaimed channel, and the stability of the reclaimed channel. The stability of both of these is at present unknown.

The erosion rate of the reclaimed surface would be higher than that of the natural surface. However, because of the flat surface, little of this sediment would reach stream channels.

In the long-term, perhaps thousands of years, the reclaimed surface is geomorphically unstable. The single reclaimed stream channel is insufficient to efficiently drain the reclaimed surface, and in time, tributaries to that channel would develop. This would be a long slow process and although accompanied by higher than natural erosion rates should not inhibit revegetation or reclamation. The location of these tributaries cannot be predicted at the present time, because their location would be controlled by initial surface irregularities controlling the direction of overland flow.

Little information is provided by the applicant about the reclaimed stream channel. However, the channel would probably not be geomorphically stable because the channel is arbitrarily given the same slope as that of the reclaimed surface. This might not be the equilibrium slope for the discharges and sediment loads that the channel would carry. As a result, the channel would be subject to erosion and deposition, and would have to be artificially maintained.

An unknown amount of sediment and water would be added by the reclaimed stream drainage basin to Spring Creek. However, because the drainage area of the reclaimed stream would be much less than the drainage area of Spring Creek above the mine, it is unlikely that enough water or sediment would be added to upset the geomorphic equilibrium of Spring Creek.

(2) Overburden

Under the Central Field Mine Plan, the overburden stratigraphy of the mine site, as it now exists, would be irretrievably destroyed. However, the area in which the overburden stratigraphy would be destroyed is reduced from that of the original plan. Destruction of the stratigraphy would still affect groundwater, soils, and vegetation. Changes

in the impacts to these disciplines will be discussed in their respective sections.

b. Hydrology

Implementation of the Central Field Mine Plan would eliminate some of the surface water impacts identified in the original mine plan, and reduce other impacts. Surface water supply would be reduced on the mine area but stock ponds would remain along South Fork Spring Creek. The perennial spring might dry up. Problems associated with the stream diversion in the original plan would be eliminated because this plan proposes no major diversions. The reclaimed stream channel would direct an unknown amount of runoff and sediment to the Spring Creek drainage. However, the amount of water and sediment should remain low and the geomorphic stability and water quality of Spring Creek would not be affected.

Under this mine plan, the impacts to groundwater would remain much the same as those in the original mine plan. A portion of the Anderson-Dietz aquifer would be destroyed, and the quality of ground water in the Anderson-Dietz aquifer east of the permit area would be degraded and might become unusable for livestock. Although the alluvial aquifer would not be disturbed, the nearness of mining activities would lower the groundwater table an unknown amount. This might cause the perennial spring and alluvial wells along South Fork Spring Creek to dry up.

(1) Surface water

Under the Central Field Mine Plan, the major stream diversions of Spring Creek and South Fork Spring Creek proposed in the original mine plan would be reduced to two minor stream diversions along Spring Creek. As a result, the problems associated with the diversions in the original plan (increased hillslope erosion, erosion along the diversion channels themselves, and the lack of sediment settling facilities) would be eliminated.

According to this mine plan, the channels of Spring Creek and South Fork Spring Creek would remain, for the most part, undisturbed. As a result, three stock ponds and the perennial spring located along South Fork Spring Creek would be left intact. Mining should have no effect upon the stockponds, but mining could disturb groundwater flow in the alluvium and the perennial spring might dry up. Three other stock ponds, two on tributaries to Spring Creek, and one adjacent to South Fork Spring Creek would be destroyed during mining.

The railroad spur and access road would be the same as those proposed in the original mine plan, and they would not likely yield significant amounts of sediment.

The sediment yield from much of the reclaimed surface would be low because of the flat nature of the surface. However, the reclaimed stream channel would provide efficient transport for sediment produced along the central portion of the reclaimed surface, and an unknown amount of sediment would be added to the Spring Creek drainage. If the reclaimed stream channel would remain geomorphically stable (See Section VIII-E-4-a, Topography and Geomorphology), the sediment yield from the reclaimed surface would remain low.

Under this mine plan, the addition of the stream channel to the reclaimed surface would allow runoff from the reclaimed surface adjacent to the channel to enter the Spring Creek drainage. This could affect water quality. However, change in water quality would be small because the reclaimed surface has a much smaller area than that of the Spring Creek drainage above the mine site, and because of the flatness of the reclaimed surface, much of the reclaimed surface would not drain to the stream.

(2) Ground water

Under the Central Field Mine Plan, the alluvial aquifer along South Fork Spring Creek would not be disturbed. However, because of the nearness of mining activities, the water table in the alluvium would be lowered and the aquifer might even be completely drained. The extent to which the aquifer would drain depends upon the degree of hydraulic contact between the alluvium and the bedrock and coal aquifers. The alluvial ground water source for the perennial spring might be lost. Two alluvial wells along South Fork Spring Creek would not be destroyed under this mine plan, but if the water table in the alluvium is sufficiently lowered, the wells might become dry. Any lowering of the groundwater table in the alluvium would not be restored during reclamation.

A portion of the Anderson-Dietz aquifer would be destroyed with the implementation of this mine plan, but the area of disturbance would be less than in the original mining plan. Two wells adjacent to the permit area would be adversely affected. The water level in a well in the NE1/4 NE1/4 of sec. 31 might drop to near the bottom of the hole, and the unused well in the west central part of sec. 24 might become dry. Deeper aquifers exist to provide an alternate source of ground water.

The quality of ground water would be decreased in the Anderson-Dietz aquifer east of the permit area. Dissolved solids leached from the spoils, probably dominated by sodium and sulfate ions, would be carried downdip along coal and clinker aquifers east of the permit area. An indication of the water quality that might be expected is provided by ground water samples obtained from spoils at Decker. These samples contain about 4,300 mg/L dissolved solids, and may not be suitable for either domestic or livestock use. Water moving to the east would be diluted by local recharge but it is not certain that the water would be

sufficiently diluted for livestock use. Leaching of the Spring Creek mine spoils would not be expected to add a significant amount of dissolved solids to the Tongue River.

c. Climate

The impacts arising from this proposal are essentially the same as those described in Section III-C.

d. Air Quality

The impacts arising from this proposal are essentially the same as those described in Section III-D.

e. Soils

The Alternative mine plan submitted by the applicant for the Spring Creek permit area does not offer any changes in reclamation procedures. Therefore, the comments made in Chapters II and III must stand. Those few differences which would occur are discussed below.

The most obvious difference to soils and reclamation would be a reduction in annual and total acres disturbed by mining. Other categories of disturbance would remain unchanged from the original mine plan.

Reductions in mining acreage would amount to about 20 acres per year, or 500 acres during the life of the mine. The relative reduction in acreage is less than the reduction in available "topsoil" material, because the depth of salvageable soil in the depleted area is greater than the average for the entire permit area.

The alternate mining and reclamation plan provides for an average "topsoil" material depth of 23 inches, apparently assuming a maximum Electrical Conductivity of 8.5 mmhos/cm. This is not likely to be permitted, and it is more probable that 11 inches of "topsoil" material would be available for reclamation.

Assuming no other change in the reclamation procedures, the net result of the alternate mine plan's reduction in "topsoil" material would be a reduction to some degree for the chances of successful reclamation throughout the permit area.

Overburden conditions are not materially altered. The alluvial area to be deleted includes four core holes. The characteristics of the materials from these holes are representative of the range found among all of the core holes in the permit area.

f. Vegetation

Impacts on vegetation, arising from the implementation of the Central Field Mine Plan, would result in the destruction of vegetation on about 3,000 acres, or about 30 percent less area than would be affected under the original mine plan. Vegetation communities included in the

scrub, grassland, and steppe physiognomic types would be the most severely impacted vegetation types with a very few acres of the ponderosa pine/juniper community being disturbed. The riparian community along South Fork Spring Creek would not be physically disturbed; however, should mining activities disrupt the ground water flow in the alluvial aquifer, this community would be deleteriously affected (section VIII-E-4-b). A lowering of the ground water table may result in a deterioration of the productivity of the community and the eventual loss of the deciduous trees and shrubs of the community.

Mining and the ensuing reclamation would result in a loss of species diversity within the disturbed area and a total destruction of the vegetation mosaic (section III-F). By not mining the area south of South Fork Spring Creek, however, the mining plan avoids the disturbance of more extensive areas which support species which have been difficult to establish on reclaimed lands. Because of the reduction of the central bluffs to a flat plain, several microenvironments would be eliminated and thereby effectively preclude some species, such as skunkbush, from the reclaimed surface. The duration of impacts on vegetation would be similar to the time frames discussed in section III-F.

g. Wildlife

Mining in accordance with the Central Field Mine Plan would significantly alter the impact assessments of the original mine plan on some species while other species would be impacted to a similar degree. The result of mining under the alternate plan would be the loss or disturbance of about 3,000 acres all of which is classified as wildlife habitat. The carrying capacity of the entire permit area would be individual species which have more specialized requirements currently provided for in the permit area.

(1) Antelope

Impacts to antelope would be essentially the same as under the original mine plan (section III-G-2); this is so because the alternate mine plan would not significantly alter the intensity or extent of disturbance to antelope habitat.

(2) Mule deer

Impacts to mule deer would be greatly reduced by the alternate mine plan as compared to those forcast under the original mine plan. Although human activity may reduce the utilization of the "major use area" along the bluffs to the south of the mine area, this impact would be completely offset by the bluffs not being disturbed by mining. Major north-south and east-west migration routes between "major use areas" and local movement patterns would be blocked by mining activities and the railroad corridor.

(3) Other mammals

Small mammal populations would be impacted to the same degree within the mining area as forecast in section III-G-3. However, the elimination of the southern portion of the original mine area from disturbance would greatly reduce the impacts which would have been otherwise generated.

(4) Upland game birds

Mining under the Central Field Mine Plan would impact sage grouse to a lesser degree, than they would be impacted by the original mine plan. Although the alternate mine plan would disturb only a portion of the sage grouse wintering area, this disturbance would effectively reduce the carrying capacity of the wintering area an unknown amount. The destruction of the "lek" would not be significant since subdominant males would probably establish a new "lek" in the general vicinity of the wintering area. The overall effect of mining a reduced area would be the maintenance of a dense cover of big sagebrush immediately adjacent to the mine area which would tend to make the reclaimed area more attractive to sage grouse as compared to the original mine plan.

Impacts to other upland game birds would be reduced owing to the reduced acreage disturbance of the alternate mine plan.

(5) Raptors

Impacts to raptors would be greatly reduced from those impacts forecast in section III-G-5. This reduction would result from the decreased area to be disturbed. Mining would destroy nesting habitat in the central bluffs which would displace raptors which nest in this area. Subregional populations of raptors would be insignifically lowered as a result of the implementation of this mine plan.

(6) Song Birds

Impacts to song birds would be reduced by the corresponding reduction in the mining area. These impacts would not be significant.

(7) Amphibians and reptiles

Impacts to amphibians would be largely eliminated and the impacts to reptiles would be generally unchanged (section III-G-7).

h. Sociology

Impacts to sociology, generated by the alternate mine plan, would not be significantly different from those impacts generated by the original mine plan (Chapter III).

i. Economics

Given the alternative of mining 7 million tons of coal per year rather than 10 million tons, the resulting economic impacts would not be altogether the same. Using the Coal Town II Model, differences have been estimated for the two respective mine sizes. Although some differences are found in Big Horn County, the major ones, as shown in tables VIII-1 and VIII-2, are found in Sheridan County where the majority of impacts would be expected to occur.

In Big Horn County, population changes, migration trends, the growth in employment and employment/population ratios, ancillary wages, and the growth of the city of Hardin are all estimated to have the same trends, between 1978 and 1990, with either size mine. County surpluses would be less in Big Horn County with the 7 million-ton-per-year mine because the revenues would be less. School district surpluses would also be less because of smaller revenues. There would be no change in the estimated number of school children, projected to 1990.

Some differences to be felt in Sheridan County, resulting from the company's alternative production rate, would be in the areas of migration trneds, employment/population ratios, and ancillary wages. City revenue per person, in the city of Sheridan, is expected to be the same in either case, and little difference is foreseen in the number of school children in the Sheridan school districts whether the company mines 7 million or 10 million tons of coal per year.

State revenues going to the State of Montana are estimated to differ between the two production rates, as indicated in table VIII-2. The State of Montana would also lose approximately $16 million per year in severance tax, by 1990, if the mine were operated at a production level of 7 million instead of 10 million tons per year. Differences in contributions to Wyoming State revenue, Sheridan County surpluses (shortfalls) and negative school surpluses would be negligible under the two production rates.

Impacts to community services, land use, transportation, recreation, cultural resources, and esthetics, generated by the alternative mine plan, would not be significantly different from those impacts generated by the original proposal (analyzed in Chapter III).

TABLE VIII-1.--Economic differences between mining capacities of the Spring Creek mine at 7 million tons per year and 10 million tons per year, 1978-1990

Projected economic data with Spring Creek mine at a capacity of 7 million tons per year									
	Big Horn County				Sheridan County				
Year	Economic base employment	Ancillary employment	Total employment	Population	Economic base employment	Ancillary employment	Total employment	Population	Sheridan population
1978	2,244	2,264	4,508	10,609	4,411	6,234	10,645	23,081	16,328
1979	2,202	2,346	4,548	10,600	4,564	6,454	11,018	23,610	16,857
1980	2,202	2,445	4,647	10,694	4,874	6,744	11,618	24,502	17,749
1981	2,259	2,573	4,832	10,985	4,483	6,796	11,279	24,087	17,334
1982	2,259	2,679	4,938	11,160	4,496	6,846	11,342	24,288	17,535
1983	2,259	2,783	5,042	11,341	4,498	6,975	11,473	24,602	17,849
1984	2,259	2,889	5,148	11,533	4,498	7,110	11,608	24,932	18,179
1985	2,259	2,996	5,255	11,733	4,498	7,242	11,740	25,263	18,510
1986	2,259	3,104	5,363	11,975	4,498	7,371	11,869	25,672	18,919
1987	2,259	3,213	5,472	12,222	4,498	7,510	12,008	26,092	19,339
1988	2,259	3,323	5,582	12,474	4,498	7,645	12,143	26,510	19,757
1989	2,259	3,434	5,693	12,729	4,498	7,777	12,275	26,921	20,168
1990	2,259	3,546	5,805	13,491	4,498	7,906	12,404	28,382	21,629

Projected economic data with Spring Creek mine at a capacity of 10 million tons per year									
	Big Horn County				Sheridan County				
Year	Economic base employment	Ancillary employment	Total employment	Population	Economic base employment	Ancillary employment	Total employment	Population	Sheridan population
1978	2,244	2,264	4,508	10,609	4,449	6,251	10,700	23,165	16,412
1979	2,202	2,346	4,548	10,600	4,519	6,446	10,965	23,529	16,776
1980	2,202	2,445	4,647	10,694	4,439	6,547	10,986	23,533	16,780
1981	2,259	2,573	4,832	10,985	4,534	6,679	11,213	23,972	17,219
1982	2,259	2,679	4,938	11,160	4,534	6,836	11,370	24,316	17,563
1983	2,259	2,783	5,042	11,341	4,534	6,967	11,501	24,631	17,878
1984	2,259	2,889	5,148	11,533	4,534	7,098	11,632	24,957	18,204
1985	2,259	2,996	5,255	11,733	4,534	7,231	11,765	25,292	18,539
1986	2,259	3,104	5,363	11,975	4,534	7,363	11,897	25,706	18,953
1987	2,259	3,213	5,472	12,222	4,534	7,504	12,038	26,131	19,378
1988	2,259	3,323	5,582	12,474	4,534	7,641	12,175	26,554	19,801
1989	2,259	3,434	5,693	12,729	4,534	7,775	12,309	26,970	20,217
1990	2,259	3,546	5,805	13,491	4,534	7,906	12,440	28,438	21,685

TABLE VIII-2. -- Fiscal Comparisons of Spring Creek Mine at 7MTY and 10MTY Production Levels 1978-1990

PROJECTED FISCAL VALUES WITH SPRING CREEK@ 7MTY								
	Big Horn County				Sheridan County			
Year	State Revenue	County Surplus	School Surplus	Mt. State Income Tax paid by miners	State Revenue	County Surplus	School Surplus	No. of School Children
1978	33,157,696	584,925	1,099,620	1,186,345	2,906,476	-4,978,476	119,701	6,060
1979	41,856,704	1,182,550	2,559,634	2,406,558	4,679,148	-5,572,442	-167,970	6,199
1980	60,259,056	837,989	3,205,104	1,852,254	5,067,235	-8,736,533	-3,971,264	6,433
1981	84,187,312	1,417,041	5,113,795	1,290,399	5,023,975	-6,147,880	-515,297	6,324
1982	89,681,760	1,904,415	6,681,688	1,309,079	5,605,911	-10,416,087	-5,963,688	6,377
1983	102,357,408	1,966,140	6,895,887	1,311,953	5,863,690	-10,052,099	-5,262,501	6,459
1984	109,105,088	2,056,640	7,179,496	1,311,953	6,169,975	-10,141,720	-5,150,515	6,546
1985	114,910,400	2,130,818	7,402,908	1,311,953	6,528,096	-10,746,169	-5,709,762	6,633
1986	121,000,432	2,117,249	7,326,976	1,311,953	6,976,402	-12,415,809	-7,647,900	6,740
1987	127,039,328	2,248,390	7,721,260	1,311,953	7,307,998	-11,761,486	-7,946,902	6,850
1988	133,773,888	2,314,972	7,895,621	1,311,953	7,775,475	-13,610,098	-8,653,489	6,960
1989	140,849,776	2,393,883	8,103,769	1,311,953	8,230,613	-14,517,844	-9,552,275	7,068
1990	149,854,256	1,943,015	6,381,498	1,311,953	12,659,604	-19,848,864	-15,604,007	7,451

PROJECTED FISCAL VALUES WITH SPRING CREEK@ 10MTY								
Year	State Revenue	County Surplus	School Surplus	Mt. State Income Tax paid by miners	State Revenue	County Surplus	School Surplus	No. of School Children
1978	33,157,696	584,925	1,099,620	1,240,921	2,920,703	-4,995,746	117,301	6,082
1979	41,856,704	1,182,550	2,559,634	1,341,906	4,642,104	-5,251,832	235,539	6,177
1980	62,451,840	904,096	3,424,281	1,227,172	4,686,206	-5,617,345	-94,374	6,178
1981	86,391,168	1,486,474	5,344,001	1,363,684	5,248,138	-9,340,162	-4,768,031	6,294
1982	96,625,344	2,124,408	7,411,076	1,363,684	5,367,356	-7,039,418	-1,501,524	6,384
1983	109,646,768	2,196,441,	7,649,450	1,363,684	5,786,637	-8,882,557	-3,712,742	6,467
1984	116,765,152	2,297,750	7,978,897	1,363,684	6,175,357	-10,122,232	-5,121,022	6,552
1985	122,960,544	2,383,311	8,240,049	1,363,684	6,542,640	-10,838,996	-5,827,830	6,640
1986	129,460,464	2,381,758	8,203,957	1,363,684	6,986,445	-12,444,315	-7,679,437	6,749
1987	135,932,176	2,524,416	8,640,072	1,363,684	7,317,806	-11,781,085	-7,965,836	6,860
1988	143,121,904	2,605,404	8,858,550	1,363,684	7,786,087	-13,634,702	-8,676,830	6,971
1989	150,676,784	2,698,368	9,113,276	1,363,684	8,242,036	-14,547,345	-9,580,545	7,061
1990	160,184,080	2,262,275	7,440,010	1,363,684	12,671,620	-19,891,568	-15,647,843	7,466

5. Mitigating Measures

The alternate mine plan is in itself a mitigation for the impacts generated by the original mine plan. Because of the preliminary nature of the alternate mine plan submittal, specific mitigating measures have not been proposed by the Company to reduce or eliminate impacts arising from the alternate plan.

F. ALTERNATE MITIGATION MEASURES

1. GEOLOGY

Several technical alternatives exist by which erosion and deposition can be decreased, both during and after mining.

a. Increased slope erosion adjacent to the proposed stream diversions can be controlled by maintaining the gradient of the diversions as near as possible to that of the present stream channels. (see Hydrology for related alternatives).

b. Erosion of the regraded highwall can be decreased by several methods: regrading the highwall to a slope much less than the legal maximum of 20 degrees. However, this necessitates either disturbing more surface above the highwall and away from the pit, and/or requiring the operator to find more spoil to accomplish same. Creating either a stepped slope, or some form of a concave or convex upward slope, as opposed to the proposed straight, regular slope. Any of the above would diminish slope erosion rates, although by an undeterminable degree.

c. A variation on 1.b., above, would be to require the operator to mine southward to the face of the resistant sandstone unit forming the south bluff mentioned in Chapter II. The exposed bluff is more resistant to erosion, as well as more natural appearing. If used selectively, the method may also allow more spoil to accomplish variations of 1.b., above, or point d, below.

d. To diminish the headcutting of ephemeral drainages which would drop abruptly over the regraded highwall, spoil may be backfilled adjacent to those drainages such that a more natural and stable concave upward drainage profile would be attained. In so doing, however, small alluvial fans would result which may in some instances allow the transport of sediments as far as the reclaimed stream channels. It is

conceivable that downstream sedimentation could occur subsequent to major runoff events.

2. HYDROLOGY

If it is deemed necessary to restore the shallow water table, this can be done by constructing a water retardant layer of material below the new artificial flood plain of South Fork.

Wells that are destroyed or dried up should be replaced when they are needed for watering livestock upon completion of the mining and reclamation processes. Some of the wells may be able to develop water from the resaturated spoils in places where there is sufficient thickness of saturation, the water from the spoils will probably be high in dissolved solids. Most of the wells will need to extend to sandstone or to other coal aquifers in the Fort Union Formation below the mined out area. The quality of the water generally improves with depth. A discussion of the changes in quality with depth is given in Chapter II. A potentially contributing source of ground water to the spoils is from spoil areas that have not been revegetated. Therefore the primary effort for the prevention of the leaching of spoils should concentrate on the prompt revegetation of the spoil surfaces. Deep, as well as shallow, rooted vegetation is desirable to more completely utilize the soil moisture and to prevent deep recharge of soil water into the spoils.

3. AIR QUALITY

a. NERCo, in conjunction with the Air Quality Bureau and the Environmental Protection Agency should design an implementation plan for monitoring the air quality in the Spring Creek area before, during and after mining operations. Approval of the mining permit application should be contingent upon such as agreement.

b. The best available technology for the abatement and control of particulate and pollutant gases should be employed. For example, all conveyor belts from the dumping area to the crushers and loadout should be completely covered. Water-spraying equipment should also be installed at various points on the conveyors. Before loading onto the unit trains, all coal should be treated with a dust suppressant. Hot oil has been used successfully for this purpose and does not interfere with the combustion properties of the coal.

c. Temporary topsoil or overburden stockpiles should be stabiized with organic substances such as hydromulch. Stockpiles (topsoil) which will not be used for over a year should be stabilized with vegetation.

4. SOILS

The mining and reclamation plan submitted by the applicant does not address many of the chemical limitations placed on successful reclamation by the characteristics of both the soils and the overburden found on the proposed minesite. There are a number of possible approaches which could be used to enhance the chances of a successful reclamation program. These techniques would be designed to limit the amount of toxic, potentially toxic or otherwise undesirable material at or near the reclaimed surface.

a. Selective Salvage of Overburden. There is a significant volume of non-saline, non-sodic overburden within the Spring Creek permit area, which could be selectively salvaged for placement over less desirable materials. This procedure would provide a buffer between the relatively thin veneer of "topsoil" material and the sodic overburden. Rooting depths, infiltration rates and, ultimately, reclamation success would be enhanced.

b. Detailed soil characterization. During the course of mining, approximately 70 acres per year will be disturbed. This is a relatively small area, and could readily be fully characterized and staked for maximum salvage. Salvage operations should be supervised by reclamation personnel to assure full utilization of available soil resources.

Field checks by State soil scientists indicate that there is somewhat more salvageable "topsoil" material in the central bluff area within the permit area than shown in the original soil survey. Soil survey revisions in progress should correct this situation.

c. Management Alternatives

The problem of long term impacts and characteristics of the post-mining reclamation surface has been discussed in Chapter III. There is a need to assure the full reclamation of the mined surface, which would permit the reintegration of the area into the local patterns of land use. The release of the reclamation bond presently is predicated on vegetative composition of density. A competent reclamation team working with a well developed and executed mine plan should be able to produce a reasonable vegetative stand during the life of the mine and the subsequent bonding period. Unfortunately, under these conditions, species composition and density is not an indicator of landscape stability.

There is a need for special management or use restrictions in the post-bonding period which will insure the integrity of the reclaimed surface until it can be demonstrated that the area is as stable as adjacent areas, and can be used in the same manner. The duration of such a period is unknown. Estimates may range from decades to centuries.

The means of instituting and enforcing requirements which would effect these goals would undoubtedly be controversial. The means, at this point, however, are relatively unimportant. The importance lies in the fact that the effectiveness of reclamation at Spring Creek, as well as other mine sites, has not been demonstrated. There is no assurance that normal land-use patterns for the region can be safely reinstituted a decade after mining.

5. VEGETATION

a. Fertilizer

(1) Apply fertilizer, if indicated by test results, at time of seeding on acres with slopes greater than 5:1. This would minimize the likelihood of it being blown or washed away (Cook et al, 1974).

(2) Do not apply nitrogen fertilizer to trees or shrubs after July 1. This would prevent excessive late summer growth and encourage proper maturity and hardening (Carlstrom, 1972), thereby minimizing winter injury.

(3) Limit reclamation use of topsoil and non-toxic substrate to material not exceeding 2 ppm molybdenum content. This has been proposed by Miles City BLM, after consultation with several State and Federal agencies and institutions, as being the soil suspect level for the element. Excessive molybdenum relative to elemental copper, i.e. a copper:molybdenum ratio of less than 2:1 in forage can cause molybdenousus in cattle (DePuit, 1977).

b. Seedbed preparation

(1) Where rubber-tired tractors are used, reduce tire pressure to the lowest recommended for a given load. Eriksson et al (1975) indicated that this procedure significantly reduces topsoil compaction, thereby allowing greater vegetation production.

(2) Use dual rear wheels on tractors when rubber-tired models are used. This measure would help reduce tire-soil pressure toward 14.2 lbs./in.2, the approximate pressure, when exceeded (Driksson et al, 1975) can create soil compaction problems and impair vegetative growth.

c. Seeding

(1) Use grass seed grown only within 300 miles north or 200 miles south of origin; however, adjustment may be made for elevation (Anonymous, 1977). Further, seed for warm season grasses should be used only from immediately local sources up to 150 miles south.

(2) Seed by drilling a pure live seed (PLS) mixture of 3-5 forb seeds, 2 shrub seeds, and the remainder grass--not to exceed approximately 45 PLS per $ft.^2$. This mixture would provide a good balance by vegetation class and be suitable for more critical sites such as west and south slopes (Cook *et al* 1974), while minimizing interspecific competition.

(3) Drill all seed on slopes of 3:1 or less in lieu of partial broad casting. The chance for successful germination and establishment with broadcasting, whereby seed is covered with soil, is greatly increased (Anonymous, 1977; Wambolt, 1976; Cook, 1966).

(4) Drill all grass seed to a depth of approximately 1/2 inch. This would be about optimum for average-sized grass seed for maximum germination (Anonymous, 1977: Wambolt, 1976: Cook *et al*, 1974).

(5) Plant browse species shallow--approximately 1/16 to 1/4 inch deep. This depth is recommended by Cook (1974), and Deveraux (personal communication, 1977) feels that broadcasting 4-wing saltbush will produce better results.

(6) Use only certified seed. This will insure quality seeds as they must "...meet minimum requirements as to germination and limitations on weed seeds, other crop seeds, and inert matter" (Vallentine, 1971).

(7) Modify seed bins on drill, if not already equipped, to include an agitator which will (Anonymous, 1977) promote uniform seed stands, thereby minimizing interspecific competition, weed competition, and bare spots.

(8) Inoculate with the proper bacteria all legume seed within 48 hours (Anonymous, 1977) prior to planting. Legumes are dependent upon certain bacteria for makeing nitrogen form the air available for use by the plant. Inoculation of legumes by the proper strain of *Rhizobia* bacteria can insure natural nitrogen availability in the soil as legumes decompose in the soil (Vallentine, 1971). This available nitrogen would be necessary after that from initial artificial fertilization has been depleted.

(9) Use tubelings for transplanting trees and shrubs. Hodder (1977) suggests the superiority of this method in making deep stored soil moisture more available to the plant roots.

d. Post-seeding management

(1) Implement measures for controlling undesirable insects and rodents. Insects, particularly grasshoppers and harvester ants, and several kinds of small mammals would very likely destroy 25-75 percent (estimate) of new seedlings established through reclamation. Vallentine (1971) documents seedling destruction by some species such as prairie dogs, gophers, mice, rats, voles, and jackrabbits. He further states that jackrabbits often crop off seedling grasses as fast as they emerge. This was a problem particularly in small seeded areas bounded by unimproved range since jackrabbits usually move from unimproved areas to concentrate on new seedlings. Pocket gophers would be a problem since much of their diet consists of roots, rootcrowns, and regenerative organs, including rhizomes (Vallentine, 1971). Harvester ants would probably consume up to 25 percent (estimate) of newly emerging vegetation. These ants have been known to produce barren areas around the ant hills on up to 10 percent of the land area (Vallentine, 1971). This source also documents foraging by the ants up to 100 feet from their nests to collect seeds which are their main diet.

((2) Prohibit off-road vehicle use on seeded areas until the vegetation is well-established.

6. WILDLIFE

a. Tree and shrub species valuable to wildlife could be planted on revegetated areas in densities similar to those existing before mining.

b. Game management areas could be established on reclaimed lands or other Spring Creek Coal Company lands adjacent to the mining area.

c. Human activity in areas not being mined could be kept to a minimum to reduce wildlife disturbance.

d. Variances to the State of Montana Reclamation laws could be sought to the benefit of wildlife i.e. retaining highwalls and water bodies.

7. SOCIAL AND ECONOMIC

The State of Montana (based on the authority of the mine permit) could force the NERCO operation to time their construction such that the impacts of this mine was timely relative to other construction and mining activity. This could decrease the total demand for construction workers in the area. The State of Montana, however, has no incentive to develop such a policy because the major socio/economic impacts are

being felt in Wyoming, not Montana. The State of Wyoming has no control over the allowance to permit this Montana mine. Local authorities can only govern as the impacts occur.

The State of Montana Coal Severance Tax could help alleviate problems in Montana but not in Wyoming. Communities that qualify could utilize such funds to solve impact problems. The Montana Coal Board (appointed by the Governor) disperses such funds in the form of loans and grants. Previous rulings by the Attorney General of the State of Montana have ruled that such funds cannot be used on the Indian Reservation which does not enable Indians to participate in such funding. If allowed, greater mitigation would be possible because of the sizeable Indian population in Big Horn County.

Another possible State mitigating factor is the fact that the State of Wyoming has an Industrial Siting Act (initiated by the Wyoming State Legislature) which established a State Siting Board which permits or disallows industrial sites to locate. Pacific Power & Light, the parent company of NERCO has shown great interest in location of an electrical generator plant in Sheridan County at Prairie Dog Creek. If the Wyoming State Siting Board did not allow this plant to locate, less impact would occur to the local area. Although this is not a direct mitigation on the NERCO coal mine, it is a possible consideration because NERCO coal output would undoubtedly be used in the power generation.

The State of Wyoming established the Wyoming Community Development Housing Authority in 1975. The purpose of this authority is to enable impacted communities the ability to borrow funds (long term) for public works projects as well as public housing. Because the State of Wyoming has a ceiling on the maximum mill allowed any municipality, these funds enable new forms of immediate purchasing power for impacted communities. The City of Sheridan could use this to solve various problems.

a. County Mitigation

City-County planning does exist in Sheridan County, Wyoming as does County planning in Big Horn County. Such bodies have the ability to regulate and influence land use policies in specific impacted areas as well as establishing preplanning which is essential for impacted areas. These entities could be major tools used in mitigation.

Improvement of public roads and bridges as well as an overpass or underpass in Big Horn County on Highway FAS 314 might help solve some of the congestion which is occurring and will continue with the new NERCO mine.

For any impacts that do occur in Big Horn County, (although expected to be sizeably less than Sheridan County, Wyoming) surplus property taxes should be available to solve many of the particular

problems that may evolve. If a corporate town were established on the Montana side, these surpluses may not be as substantial. The school districts within Big Horn County should experience additional funds based upon increased assessed valuations of property. If the impacts of new students remains on the Wyoming side, these school districts should have few problems and in fact, improve their budget situation.

Sheridan Junior College located in Sheridan is a two year institution which might possibly be used to train technicians for coal mining and related developments. In turn, such activities could enhance the College's status as an academic institution. Already an energy program has been established to train individuals in coal related activities.

Cities in Wyoming may utilize special assessments on their residences to retire bonds for contributions of specific public facilities. New subdivisions could pay out additional property taxes to finance street, water and other public facilities.

b. Corporate Mitigation

If NERCO commits itself to hiring local labor and if the local labor force is suitable, it may tend to decrease the in migration of workers and decrease the demands on housing and public facilities.

The Wyoming/Montana Industrial Association (non-profit) are those coal development corporations which have formed an association to "assist communities where industry can assist them"[1]. This organization might possibly aid in solving impact problems. Actual commitment by this group could help counter some impacts.

c. Federal Assistance

Federal assistance for impacted areas is also available for specific categories. The Federal Energy Administration (currently D.O.E.) has made a list of assistance by category. For further information, this list is on file at the office of the U.S. Geological Survey, EIAP, Box 25046, Mail stop 701, Federal Center, Denver, Colorado 80225.

Further impact-assistance is pending in Congress and will be made available later.

8. COMMUNITY SERVICES

There are a variety of technical alternatives for providing water, sewer and other public services. An option which could be applied

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[1] Sheridan Press, September 21, 1977.

there is local political resistance to consolidation because it is seen as a loss of direct control. For this reason, some unifications which would result in more efficient operation would not be implemented.

Some of the most important alternatives which need exploring are ways to get sufficient funding where it is needed and when it is needed and at the same time preserve equity and prevent over capitalization.

Several common schemes are applicable to this situation, prepayment of taxes, intergovernmental tax sharing and state funding mechanisms. Corporate prepayment of taxes has been used in several instances. However, in Montana, corporations feel that the 30% severance tax should pay for all impact mitigation, and the State are reluctant to do anything further. It is also true that for a given corporate expenditure, local governments get twice as much revenue from production, or severance taxes than from prepaid taxes. This is due to the nature of Federal tax codes under which prepaid taxes become capital investment and are depreciated. Companies are therefore obviously more willing to have money taken from production. There is also a problem with the spatial distribution of impact. It may be difficult to allocate prepaid taxes to the governmental entities which will actually experience the impact.

Another alternative solution is intergovernmental tax sharing, which avoids some of the problems of the first solution. Wyoming has a Joint Powers Act, and Montana has the Interlocal Agreement Act which allows local governmental entities to join together for specific tasks. This is often used for joint planning programs or construction of a joint facility. It is very unlikely however, that this method would be used to funnel money from the tax base to the impact area. Such tax sharing would almost have to imposed by the state to overcome local political problems. Even so, the state line would still be a barrier to the flow of funds.

Either of these systems, or modifications of them provide adequate service within a state. Neither can address multi state issues. At this point, only the Federal government can provide the necessary assistance. This could be done by redistribution of Federal severance taxes, similar to the Montana system, or by raising and distributing money as in the Wyoming system.

Northern Energy Resource Company (NERCO) has made plans to establish a construction camp near Decker, Montana (June 1978). The creation of a camp of this sort would reduce additional pressures placed on Sheridan County, Wyoming. Montana would also benefit by retain at least some of the purchasing power of the workers. Big Horn County would gain additional property taxes from the camp. During the construction phase of the Spring Creek mine, some of the construction workers' children would undoubtedly attend the elementary school at Decker. The increased students could stress what is a very small rural one-room school. High school age children would commute to school in Sheridan, Wyoming.

An alternative which would have a major effect on all community services throughout the region is a possible new town near Decker. The idea has been around for some time and many people, including Decker Coal Company, have taken an interest at some time or another. The most current proposal is being developed by a private consortium, which, as of June, 1978, is trying to finalize the land. Ultimately the town might reach 3,000 people and have schools, commercial areas, parks and landscaping. The promoters plan to install water and sewer, streets and a temporary school in the initial phase.

Since the project is in such a preliminary phase, much remains unknown. The complete array of public services and facilities would eventually be needed. The possible sources of funding would be numerous, including local taxation. State loans and grants, especially coal tax revenues, and Federal loans and grants. It remains to be seen who will pay for the services if the town is ever built. The developers are apparently willing and able to provide necessary services which cannot be funded otherwise.

The detailed impacts and benefits of the town cannot be specified at this time. They will be a major part of the review and permiting procedures necessary before construction begins.

If the promoters can develop the town into an attractive, well designed, well rounded community, it would have numerous benefits. The impact could be at least partially contained within Montana where it is generated and where severance tax funds are available to mitigate it. If the housing could be made affordable, it would greatly reduce the strains on the area's housing market, by reducing demand, raising vacancy rates and slowing the rise in prices.

9. TRANSPORTATION

A possible alternative to rail transport of mine production is through utilization of a slurry pipeline. Such a system is presently proposed from Northeastern Wyoming to a terminus in Arkansas. Reports conflict as to the relative energy efficiencies of rail and slurry lines

and economic operation apparently requires a large diameter, large volume line (20 to 25 million tons per year). The output of Spring Creek mine would not support a major long distance slurry line although it might contribute, along with other area mines, to the operation of such a facility.

Development of a slurry transport system would require the acquisition of a right-of-way 50 to 100 feet wide and constituting approximately 6 to 12 acres per mile.1/ Authority for condemnation of right-of-way under Federal law is being sought by slurry line interests but has not as yet been granted by Congress.

Large amounts of materials, capital, and labor would be necessary to construct a slurry transport system and the operation of a slurry system under established technology requires large amounts of water to be mixed with the pulverized coal.2/ It should be noted that present Montana law explicitly excludes the use of water in slurry transport of coal from the list of recognized beneficial water uses.

Pipeline transport would mitigate some of the adverse impacts of rail movements. Crossing conflicts with other transport modes are resolved at the design and construction stage thus reducing delays and the potential for accidents. With coal moving under cover and underground dust and noise impacts should be vastly reduced. Dumping the contents of a line segment as a result of operational failure could produce massive but localized coal contamination.

Recommend that the mining company develops additional facilities at the Tongue River Reservoir to provide for the additional recreational users.

The construction of a new town in the Decker area would relieve some of the user pressures on the recreation facilities in Sheridan.

10. ESTHETICS

An alternative for reduction of visual impacts would include the painting of buildings, equipment, etc. with neutral colors which blend with the surroundings.

1/ Mitre Corporation, Resource & Land Investigation (An Approach to Environmental Assessment with Application to Western Coal Development), Aug. 1975. P VIII-2.

2/ Energy Transportation Systems, Inc. estimate that 15,000 acre feet of water would be needed to move 25 million tons of coal through their proposed line to Arkansas.

CHAPTER IX: CONSULTATION AND COORDINATION

A. ORGANIZATION OF STATE AND FEDERAL INTERAGENCY TASK FORCE FOR THE ENVIRONMENTAL STATEMENT

Instructions to prepare the statement were issued to the Geological Survey (GS) and the Bureau of Land Management (BLM) by the Secretary of the Interior on April 29, 1976. Because of some duplicate or closely related actions pending before Federal and State agencies, and because of the Montana Environmental Policy Act, the State of Montana joined with the Federal task force in September 1976, in the preparation of this environmental statement. During September 1976, a project approach was developed, including selection of team members, division of responsibilities and scheduling for the multiplicity of actions. The State task force personnel were under the administrative supervision of a State coordinator attached to office of the Commissioner of State Lands. Archaeological reconnaissance of the lease was provided by the contractural services of Anthropologos Research International, Inc. of Livingston, Montana to supplement the data provided in NERCO's mining application submitted to the State. Major inputs were provided by the Montana Departments of Natural Resources and Conservation; Highways; Health and Environmental Sciences; and Fish and Game; Montana State University, Department of Agricultural Economics: and University of Montana, Environmental Studies.

Other Federal and State agencies providing consultation to the preparation of this statement include the following:

Federal agencies	State agencies
Bureau of Land Management	Montana Bureau of Mines & Geology
Bureau of Mines	Montana Energy Advisory Council
U.S. Forest Service	Dept. of Community Affairs
U.S. Fish and Wildlife Service	
U.S. Environmental Protection Agency	
Bureau of Indian Affairs	

Additional participation and assistance were obtained from many sources. The Spring Creek Coal Co. provided data and information on their proposed activities and greatly facilitated field observations and data collection by task-force members.

B. DEVELOPMENT OF THE STATEMENT

Public notice was given in May 1976, that an environmental impact statement was to be prepared on the proposed Spring Creek mining and reclamation plan by a joint State-Federal task force.

In preparation of this draft statement, data and/or review comments were solicited form a wide range of State and Federal Agencies, County and City officials both in Montana and Wyoming, consultants and private interest groups.

A close working relationship was established with State and local agencies in Montana. All divisions of Montana State Government having jurisdictional interests in the projects have been contacted and many supplied data.

During the preparation of this preliminary draft environmental impact statement, consultation and coordination was made with the following organizations:

Government

Department of the Interior

Bureau of Indian Affairs
Bureau of Land Management
Bureau of Mines
Bureau of Reclamation
Fish and Wildlife Service
Heritage Conservation and Recreation Service
Office of Surface Mining

Other Federal Agencies:

Department of Agriculture
Soil Conservation Service
Department of Energy
Department of Health, Education, and Welfare
Department of Housing and Urban Development
Department of Labor
Mining Safety and Health Administration
Department of Transportation
Environmental Protection Agency
Federal Energy Regulatory Commission
Interstate Commerce Commission
President's Advisory Council on Historic Preservation

Montana State

Office of the Governor
Bureau of Mines and Geology
Department of Community Affairs
Department of Fish and Game
Department of Health and Environmental Sciences
Department of Natural Resources
Department of State Lands
Montana State Historic Preservation Office

Local

Sheridan Area Planning Agency
Sheridan County Commissioners
Sheridan County Planning Commission
Rosebud County Planning Director

Non-Government

Burlington Northern Railroad
Milwaukee Railroad
Montana State University
Mountain Bell Telephone Company
Northern Energy Resources Company, Inc.
Northern Cheyenne Research Project
Northern Plains Resource Council
Old West Regional Commission
Powder River Basin Resource Council
Range Telephone Cooperative
Sheridan-Johnson Rural Electric Association
Tongue River Electric Cooperative
University of Montana
VTN, Inc.
Yellowstone-Tongue Area Wide Planning Agency

C. REVIEW OF STATEMENT

In accordance with the CEQ guidelines and Montana Department of State Lands rules and guidelines, copies of the draft statement will be made available to the public for their comments and suggestions.

The draft environmental statement is available for public review at the following places:

U.S. Geological Survey Public Inquiries Office, Room 1012, Federal Building, 1961 Stout Street, Denver, CO 80202

U.S. Geological Survey Library Bldg. 25, Denver Federal Center, Denver, CO 80225

U.S. Geological Survey Library, Room 4A100, USGS National Center, 12201 Sunrise Valley Drive; Reston, VA 22092

Montana Dept. of State Lands, 1625 11th Ave., Helena, MT 59601

Bureau of Land Management, P.O. Box 940, Miles City, MT 59301

Parmley Billings Public Library, 510 North Broadway, Billings, MT 59103

Sheridan County Fulmer Public Library, 320 North Brooks, Sheridan, Wyoming 82801

Big Horn County Public Library, 419 North Custer Ave., Hardin, MT 59034

The Montana State Library, State of Montana, 930 East Lyndale, Helena, Montana 59601

The Rosebud County Library, 201 North 9th Ave., Forsyth, MT 59327

A limited number of copies are available on request from the United States Geological Survey, Land Information and Analysis Office, Box 25046, Mail Stop 602, Federal Center, Lakewood, CO 80025; and, over the counter only, from the U.S. Geological Survey Public Inquiries Office, Room 1012, Federal Building, 1961 Stout Street, Denver, CO 80202; and the Montana Dept. of State Lands, 1625 11th Ave., Helena, Montana 59601.

Written comments on the draft statement will be accepted for a period of 45 days subsequent to the filing with EPA and the Montana Environmental Quality council. All substantive comments received will be considered in preparing the final environmental statement on this proposal. Written comments should be addressed to Director, United States Geological Survey, 108 National Center, Reston, VA 22092.

Public hearings will be held in Sheridan, Wyoming and at the Squirrel Creek School, Decker, Montana.

Comments on the draft environmental statement are sought from industry, officials from all levels of government, environmental groups, and concerned citizens. Those who wish to testify at the hearings should secure a registration form from the U.S.G.S., Northern Powder River Basin EIS office, P.O. Box 1135, Room 251, 2602 First Ave. North or from the Montana Department of State Lands, Capitol Station, Helena, MT 59601. Those unable to appear at the hearings should submit written comments to: Director, U.S. Geological Survey, 108 National Center, Reston, VA 22092.

Testimony at the hearings plus the views of all concerned levels of government will be used in revising the draft statement into a final environmental impact statement to be published December, 1978.

CHAPTER X: REFERENCES

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Written communication, March 14, 1977, David Maughn, Air Quality Bureau, Montana Dept. of Health and Environmental Sciences, to Jack Reed.

APPENDIXES

Physical and chemical characteristics of overburden,
Spring Creek coal field. Volume weighted averages for test holes

Appendix A

	Test hole No.									
	308	310	317	335	348	370	376	378	379	380
PH, PASTE	8.00	8.05	8.35	7.81	8.26	8.21	8.31	8.33	8.35	8.57
SATURATION PERCENT	44.91	41.20	68.69	40.01	60.72	49.39	49.34	47.45	51.56	54.22
SOLUBLE SALTS, MMHOS/CM	1.71	5.47	3.45	3.58	5.19	6.47	5.66	3.39	2.95	3.11
NA, MEQ/L	10.82	39.96	24.58	12.08	42.05	36.31	36.43	21.16	24.96	19.92
CA, MEQ/L	2.18	5.44	1.59	8.26	1.66	3.42	4.64	3.76	0.91	2.87
MG, MEG/L	7.69	13.87	5.02	20.38	3.85	21.02	12.68	12.62	2.99	10.48
SAR	5.13	21.81	34.01	4.34	34.54	10.51	14.57	23.05	30.91	19.74
NA, WATER, MEQ/100G	0.49	1.63	1.43	0.47	2.75	1.85	1.96	0.99	1.35	1.03
NA, NH4AC, MEQ/100G	1.07	3.36	5.15	1.05	5.79	3.27	3.46	2.62	4.23	3.24
CEC, MEG/100G	15.87	12.35	15.49	15.39	15.21	23.81	19.45	18.06	17.76	22.22
ESP	3.79	14.76	25.53	4.23	19.98	5.77	8.45	10.70	17.63	11.07
P, AVAILABLE, PPM	3.32	3.78	11.20	4.86	9.25	10.43	3.62	5.80	5.06	5.81
K, AVAILABLE, PPM	208.70	244.55	289.06	228.95	338.28	291.00	326.21	269.24	332.13	270.50
NITRATE, PPM	4.34	4.53	8.15	8.20	23.78	54.54	4.67	16.19	2.39	4.30
AMMONIUM, PPM	24.81	30.58	18.37	12.98	32.37	10.47	31.01	45.48	48.91	36.14
B, WATER SOLUBLE, PPM	0.40	0.30	0.52	0.59	1.97	0.67	0.55	0.69	0.61	0.50
MO, NH4OXYLATE SOLUBLE, PPM	0.61	0.53	0.86	0.54	0.92	0.58	0.39	0.26	0.45	0.26
SE, AVAILABLE, PPM	0.029	0.025	0.020	0.012	0.025	0.025	0.025	0.025	0.026	0.033
CU, DTPA EXTRACT, PPM	6.58	5.57	8.94	7.77	5.46	3.85	6.85	4.23	5.15	4.51
FE, DTPA EXTRACT, PPM	165.52	139.72	479.19	347.65	360.09	214.31	509.75	277.70	361.10	335.34
MN, DTPA EXTRACT, PPM	41.39	37.43	27.96	62.45	23.35	67.71	43.45	26.50	25.34	57.16
ZN, DTPA EXTRACT, PPM	6.99	6.74	5.94	3.75	5.94	4.81	13.26	4.65	6.92	23.17
NI, DTPA EXTRACT, PPM	5.37	6.10	7.11	6.05	8.34	3.01	9.07	4.49	8.08	6.24
CD, DTPA EXTRACT, PPM	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
PB, DTPA EXTRACT, PPM	4.50	3.65	4.49	4.57	5.12	4.47	7.76	3.73	5.82	5.23
HG, TOTAL, PPB	32.88	36.60	42.56	39.26	74.25	56.78	91.34	40.76	63.87	52.57
VERY COARSE SAND (-2+1 MM), %	0.24	1.54	1.85	1.40	1.16	2.34	0.73	0.91	1.46	0.23
COARSE SAND (-1+0.5 MM), %	0.57	2.68	2.80	3.69	1.35	2.14	0.90	1.18	1.94	0.67
MEDIUM SAND (-0.5+0.1 MM), %	14.91	7.55	6.72	5.73	2.50	3.76	2.18	3.81	2.89	11.30
VERY FINE SAND (-0.1+0.05 MM),	15.11	8.78	13.06	8.38	4.80	7.87	6.42	8.23	3.72	11.38
SILT (-0.05+0.002 MM), %	44.35	52.17	49.78	52.85	60.89	56.86	61.00	59.35	60.25	49.42
CLAY (-0.002 MM), %	24.83	27.27	25.77	27.99	29.29	27.03	28.77	26.52	29.73	27.00

Appendix A (cont.)

Overburden traits of the Spring Creek lease area
volume weighted averages for test holes

	Test Hole No.									
	381	382	383	384	386	387	388	389	390	392
PH, PASTE	8.30	7.79	8.31	8.03	8.47	8.19	7.94	7.74	7.96	8.87
SATURATION PERCENT	54.21	39.51	59.29	53.66	88.22	53.48	45.49	57.39	95.99	71.50
SOLUBLE SALTS, MMHOS/CM	3.01	6.62	4.42	2.60	2.47	3.89	4.16	2.08	1.37	4.89
NA, MEQ/L	26.20	30.81	32.99	19.88	19.80	23.62	34.56	18.72	11.94	30.51
CA, MEQ/L	1.22	8.18	2.36	1.05	0.52	3.91	1.90	0.84	0.30	4.05
MG, MEG/L	3.52	30.70	6.43	3.49	1.39	15.97	8.06	1.13	1.29	15.01
SAR	30.30	15.42	32.04	18.26	35.32	26.46	30.93	24.90	29.60	23.92
NA, WATER, MEQ/100G	1.44	1.16	1.88	1.00	1.64	1.32	1.63	1.13	2.48	1.02
NA, NH4AC, MEQ/100G	5.36	2.54	4.49	3.00	6.00	3.80	3.77	3.86	3.26	6.59
CEC, MEG/100G	18.48	16.18	18.41	20.30	17.26	22.91	16.08	23.33	20.67	23.55
ESP	20.97	10.39	14.82	9.03	24.99	12.40	14.30	12.20	4.95	23.11
P, AVAILABLE, PPM	3.02	5.47	8.64	7.83	7.49	10.68	9.40	5.47	6.62	8.58
K, AVAILABLE, PPM	331.22	292.87	314.09	329.54	293.84	320.85	285.07	342.50	287.25	271.91
NITRATE, PPM	3.78	7.93	13.79	3.58	37.58	12.34	46.03	8.65	73.45	7.49
AMMONIUM, PPM	40.63	43.96	32.00	38.61	35.67	42.53	31.26	37.65	9.25	9.71
B, WATER SOLUBLE, PPM	0.65	0.56	0.56	0.50	0.55	0.68	0.52	0.68	0.88	1.36
MO, NH4OXYLATE SOLUBLE, PPM	0.56	0.83	0.76	1.28	1.06	1.69	0.89	0.97	1.05	0.73
SE, AVAILABLE, PPM	0.026	0.030	0.025	0.025	0.026	0.025	0.025	0.029	0.044	0.025
CU, DTPA EXTRACT, PPM	7.81	9.04	4.59	3.43	2.60	5.34	4.60	5.37	6.95	1.60
FE, DTPA EXTRACT, PPM	584.87	511.20	329.85	238.39	283.58	415.35	380.74	381.82	318.03	245.41
MN, DTPA EXTRACT, PPM	36.43	60.18	22.83	22.42	18.08	16.37	28.93	21.87	30.44	13.99
ZN, DTPA EXTRACT, PPM	14.73	20.81	7.15	11.54	5.70	7.27	8.65	5.52	8.66	3.14
NI, DTPA EXTRACT, PPM	9.62	9.82	6.83	5.85	5.90	8.73	6.87	8.71	6.91	3.25
CD, DTPA EXTRACT, PPM	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
PB, DTPA EXTRACT, PPM	5.62	6.01	3.93	4.13	2.91	4.96	4.96	5.24	5.86	3.73
HG, TOTAL, PPB	97.40	108.73	62.41	60.69	62.88	80.15	84.21	100.14	115.23	54.31
VERY COARSE SAND (-2+1 MM), %	0.96	1.17	1.22	0.54	1.18	2.94	2.76	1.07	0.68	0.70
COARSE SAND (-1+0.5 MM), %	1.15	2.09	1.55	1.01	1.26	2.69	2.30	1.46	1.35	1.44
MEDIUM SAND (-0.5+0.1 MM), %	1.96	6.90	3.24	3.17	3.17	5.75	5.63	9.57	3.01	20.92
VERY FINE SAND (-0.1+0.5 MM),	6.68	7.34	8.04	11.81	12.46	9.25	9.21	8.04	4.48	21.16
SILT (-0.05+0.002 MM), %	60.88	49.52	57.23	55.40	60.02	47.47	53.15	46.62	53.06	34.23
CLAY (-0.002 MM), %	28.37	34.39	28.72	27.94	21.91	32.48	26.96	33.18	37.43	21.46

Appendix B. -- Summary of Ground Water Quality, November 1976

Parameters	Alluvial Aquifers Wells		Anderson-Dietz Coal Aquifer Wells	
	329 P	365 D	320 D	326 P
General Characteristics				
pH, Field	7.7	7.4	7.8	7.9
Specific conductance mmhos at 25^{o}C, field	2250	2800	3550	2750
Temperature ^{o}C	11.5	11.9	14.8	13.0
Major Cations				
Calcium mg/1	190	160	30	18
Magnesium mg/1	230	290	12	6
Potassium mg/1	10	10	13	10
Sodium mg/1	130	240	800	700
Sodium Adsorption Ratio	1.6	2.6	31	37
Major Anions				
Bicarbonate mg/1	1100	1100	1200	1800
Chloride mg/1	7	8	8	10
Fluoride mg/1	.48	.59	.53	.61
Sulfate mg/1	770	1200	860	130
Nitrate mg/1	1.0	1.0	3.1	2.2
Trace Metals				
Cadmium mg/1	< .01	< .01	< .01	< .01
Chromium mg/1	< .02	< .02	< .02	< .02
Lead mg/1	< .02	< .02	< .02	< .02
Mercury mg/1	< .001	< .001	< .001	< .001
Selenium mg/1	< .005	< .005	< .005	< .005
Total Phosphorus mg/1	.30	.29	.41	.26
Iron, Dissolved mg/1	.08	.05	.10	.10
Iron, Total mg/1	1.0	3.6	.27	1.1
Manganese, Dissolved	< .01	< .01	< .01	.02
Zinc, Dissolved mg/1	.13	.13	.16	.11

Appendix D-1. -- Atmospheric particulate high-volume sampling
Decker-Shell (Youngs Creek), and Spring Creek
Units: ug/m^3

Date	Shell CIRL[1/] Site	Spring Creek Site	State-Decker Mine
(1975)			
Oct 3	47.8		
9	12.0		
15	9.3		
22	3.1		
28	2.7		
Nov 1	8.0		
7	8.0		
14	2.0		
20	4.0		
26	-1.0		
Dec 2	-1.0		20.5
8	8.0		15.7
14			14.5
16	1.0		
20	1.0		
25	4.0		
31	2.0		
(1976)			
Jan 7	9.0		
13	2.0		
17	4.0		
19			236.2
25	7.0		19.3
31	5.0		98.8
Feb 6	10.0		34.9
12			42.2
13	5.0		
18	18.0		85.6
24	7.0		
25			61.5
28	3.0		
March 1			25.3
6	3.0		
7			21.7
13	7.0		25.3
19	25.0		
25	14.0		
31	8.0		
April 6	29.0		47.6
10	50.0		
11			118.0
17	8.0		
18			20.9
24	8.0		41.8
30	18.0		81.2

Date	Shell CIRL Site	Spring Creek Site	State-Decker Mine
May 6	11.0		31.3
12	12.0		241.3
18	40.0	40.8	109.0
24		--	90.5
26	10.0	17.8	
30	24.0		20.9
June 5	34.0	37.6	
11	22.0	31.7	194.9
17	6.0	11.2	23.2
23	15.0	14.9	206.5
29	17.1	20.3	38.3
July 5	34.0	37.6	
11	22.0	31.7	194.9
12		23.1	
17			46.4
22		24.2	
23	25.0		128.8
29	31.3	35.8	134.6
Aug 4	12.9	16.5	81.2
10	14.7	24.4	171.1
16	22.9	29.6	161.2
22	27.9	21.8	125.3
28	15.0	27.9	99.8
Sept 3	7.1	47.2	187.9
9	14.3	21.1	
15	15.9	24.0	65.0
21	13.9	26.1	40.6
25	29.7		
27		16.3	26.7
Oct 3			74.2
4		14.9	
5	9.6		
9	12.3	16.6	51.0
15	12.9	17.6	
21	31.1	15.4	42.9
27		13.7	71.9
28	7.7		

Date	Shell CIRL Site	Spring Creek Site	State-Decker Mine
Nov 2	11.4	30.4	95.1
6	7.9		
8		19.5	149.6
13	16.0		
14			95.1
15		36.0	
20	12.5	36.0	102.1
25	4.1		
26		13.4	109.1
Dec 1	5.4		
2		8.9	
7	4.5		
8		13.5	
13	9.4		
17	5.4		
20		38.4	
23	5.1		
28		12.4	
31	1.2		
(1977)			
Jan 4		10.0	
6		10.9	
7	6.6		
13	6.1	13.1	
19	3.9	6.1	
25	7.4	11.0	
28	6.6		
31		12.8	
Feb 4	8.1		
6		13.2	
11	7.4		
12		11.6	
17	2.8		
23	3.3		
March 2	10.4		
8	38.8		
14	6.6		
20	10.2		

[1/] CIRL refers to the Crow Indian Reservation Lease

Appendix D-2. -- Atmospheric visibility in miles [Source: Shell Oil Company, Mining Ventures CIRL (Crow Indian Reservation Lease) Monitoring Program]

Observed Time Yr	Mo	Dy	Hr	Visibility (Miles)
75	10	02		---
		08		---
		14		---
		21		30
		27		25
		31	1200	40
	11	06	1155	40
		13	1200	40
		19	1300	35
		25	1230	1
	12	01	1330	45
		07	1300	30
		15	1300	25
		19	1230	40
		24	1000	40
		30	1200	35
76	01	06	1200	2
		12	1300	4
		16	1230	40
		23	1300	35
		30	1200	35
	02	05	1230	25
		12	1225	35
		17	1210	35
		23	1155	30
		27	1030	20
	03	05	1130	35
		12	1120	35
		18	1200	35
		24	1200	35
		30	1200	35
76	04	05	1230	35
		09	1200	35
		16	1230	5
		23	1230	30
		29	1240	30
	05	05	1200	30
		11	1245	10
		16	0900	35
		25	1140	35
		28	1200	35
	06	04	1120	35
		10	1040	35
		16	1213	30
		22	1100	20
		28	1145	35
	07	02	1040	20
		09	1120	35
		16	1100	35
		22	1100	35
		28	1200	35
	08	03	1100	35
		09	1300	35
		13	1215	35
		20	1400	35
		27	1145	35
	09	02	0845	35
		08	1100	35
		14	1245	35
		20	1340	35
		24	1130	35

Appendix D-3. -- Theoretical Maximum Particulate Emissions

at a 10^6 Tons per year mine

(Derived From Emission Factors Not Developed on Site)

* EQUIPMENT & MATERIALS	* TYPE OF ACTIVITY	* # OF UNITS	* /UNIT/YEAR KM-TONS-HOURS-	PARTICULATE EMISSION MULTIPLIER	* FUEL USE /UNIT/YEAR G=GAS D=DIESEL	FUEL TOTALS G=GASOLINE D=DIESEL	MAXIMUM THEORETICAL PART. EMISSION TONS
Dragline, 56 yd^3	Stripping Overburden	1	14.91 X 10^6 T	.021 Kg/T**	Electric		313.11
Coal Shovel, 30 yd^3	Coal Loading	2	4.536 X 10^6 T	.021 Kg/T	Electric		95.26
Coal Dirlls	Drill Blast Holes	2	4,000 hr	4.54 Kg/hr	105,980 1 D	211,960 1 D	18.16
120 Ton Coal Trucks	Coal Hauling	10	86,403.3 Km	1 Kg/Km	354,654.5 1 D	3,546,545 1 D	86.40
			907200 T	.021 Kg/T			19.05
Electric Wheel Loader	Coal & Overburden Loading	1	4,000 hr	14.54 Kg/hr***	193,792 1 D	193,792 1 D	58.16
			unknown T	----------			
Overbruden Shovel	Overburden Loading	1	310,716 T	.021 Kg/T	Electric		6.53
Overburden Drills	Drill Blast Holes	2	4,000 hr	4.54 Kg/hr	Electric		18.16
120 T Overburden Truck	Overburden Hauling	5	77,232 Km	1 Kg/Km	431,490 1 D	2,157,450 1 D	77.23
			1.056 X 10^6 T	.021 Kg/T (1)			22.18
D-9 & 824 Cat (Dozer)	Reclamation, etc.	7	4,000 hr	7.27 Kg/hr	157,456 1 D	1,102,192 1 D	29.08
637 Cat Scraper	Topsoil Salvage &	3	4,000 hr	14.54 Kg/hr	257,380 1 D	772,140 1 D	58.16
	Spoil Hauling		372,859 T	.021 Kg/T			7.83
16 G Cat Grader	Road Maintenance	3	4,000 hr	14.54 Kg/hr	78,728 1 D	236,184 1 D	58.16
Water Truck, 5000 gal	Water Haul Roads	2	25,744 Km	.255 Kg/Km***	20,060.5 1 D	40,121 1 D	6.56
Explosive Truck	Explosive Work	4	16,090 Km	.255 Kg/Km	6,434.5 1 G	25,738 1 G	4.10
Lube Truck	Equipment Servicing	1	6,034 Km	.255 Kg/Km	2,838.75 1 G	2,838.75 1 G	1.54
Fuel Truck	Equipment Servicing	1	6,034 Km	.255 Kg/Km	2,838.75 1 G	2,838.75 1 G	1.54
Welding Truck	Equipment Servicing	2	6,034 Km	.255 Kg/Km	2,838.75 1 G	5,677.5 1 G	1.54
Supply Truck	Equipment Servicing	1	6,034 Km	.255 Kg/Km	2,838.75 1 G	2,838.75 1 G	1.54
Hydraulic Boom Truck	Equipment Servicing	1	6,034 Km	.255 Kg/Km	2,838.75 1 G	2,838.75 1 G	1.54
Farm Tractor	Reclamation	1	2,413 Km	.255 Kg/Km	567.75 1 G	567.75 1 G	.62
	Plowing & Seeding		80.94 ha	1.21 T/ha			97.94
Dump Truck, 10 yd^3	Road Work &	4	38,963 Km	.255 Kg/Km	12,626 1 G	13,626 1 G	7.39
	Waste Hauling		74,572 T	.021 Kg/T			1.57
3/4 T. Trucks & Sedan	Light Duty Transportation	19	12,872 Km	.255 Kg/Km	3,028 1 G	57,532 1 G	3.28
Ambulance	Medical	1	400 Km	.255 Kg/Km	94.25 1 G	94.25 1 G	.10
Mobile Crane, 100 T	Backup Equipment	1	2,413 Km	.255 Kg/Km	946.25 1 D	946.25 1 D	.62
Tractor Truck	Backup Equipment	1	2,413 Km	1 Kg Km	946.25 1 D	946.25 1 D	2.41
Forklift w/Trailer	Backup Equipment	1	2,413 Km	.255 Kg/Km	946.25 1 D	946.25 1 D	.62
Trail Cable Truck	Backup Equipment	1	2,413 Km	.255 Kg/Km	946.25 1 D	946.25 1 D	.62
Portable Water Pump	Waste Water Management	4	1,000 hr	----------	26,495 1 D	105,980 1 D	
Portable Electric Gen.	Power	2	1,000 hr	----------	11,355 1 G	22,710 1 G	
Portable Arc Welders	Equipment Maintenance	2	3,000 hr	----------	32,172.5 1 G	64,345 1 G	
Ammonium Nitrate	275 Charges, Explosives		2,903.04 T	90.7 Kg/Charge**		Total	24.94
Coal Crush-Convey Load	Sizing & Train Loading		9.072 X 10^6 T	2 Kg/T (3)		D-8,374,149 1	18,144.0
Water Gel	Explosive		498.96 T	90.7 Kg/Charge		G- 201,645	
Wind	Soil Transport		80.94 ha	1.21 T/ha**		8,575,794 1	97.94
							19,267.88 Tons

* Data Supplied by Northern Energy Resources Company

** PEDCO Environmental, For E.P.A., March, 1977

*** Final E.I.S. Eastern Powder River Coal Basin of Wyoming, Oct. 74

(1) Best estimate derival from literature

(2) Northwest Colorado Coal Final E.I.S., U.S. Dept. of Interior, Appendix D

(3) Compilation of Air Pollution Emission Factors, 2nd Edition, U.S. E.P.A. Triangle Park N.D., AP-42, page 8.20-1, 1975

Appendix D-4

The following section was prepared by Dr. Dale Bergren, now working at the Cardiovascular Research Institute in San Francisco, California.

POTENTIAL HUMAN HEALTH EFFECTS FROM EXPOSURE TO HIGH CONCENTRATIONS OF ATMOSPHERIC PARTICULATES.

Concurrent with mining operations is the generation of fugitive dust. Certainly many variables exist which influence the production of air-borne dust which is then subject to inhalation by humans and animals. Among those variables are the types of mining operations, be it surface or underground, the moisture content of the soil, as well as the processes of loading, unloading and transportation.

The inhalation of sufficient amounts of any dust over a prolonged period of time will produce some type of disease, either irritative or chemical.(1) However, dust containing silicates have been well documented in contributing to the development of respiratory diseases.

Exposure to dust during the mining of coal may lead to one of three pulmonary disorders; coal workers pneumconiosis, silicosis and industrial bronchitis. The conditions of pneumoconiosis and silicosis and also silicosis and bronchitis are known to co-exist.(2)

Of the three respiratory disorders, silicosis is the most common and the most serious. Silicosis is caused by the inhalation of silicates which are air-borne having diameters ranging from 0.5 microns (u) to 5.0 microns. Above 5 microns dust particles are trapped along the upper respiratory tract, such as the nose, pharynx and the upper bronchial tree. These particles are trapped by mucus lining the surface and then are easily removed from the respiratory system by the cillated cells which line this surface. Dust particles below 0.5 microns remain suspended throughout the respiratory cycle and therefore are exhaled. These smaller particles hence do not influence the function of the lungs. Particles having diameters between 0.5 and 5.0 microns do have the potential to reach the areas of the lung where gas exchange occurs; the respiratory ducts, the antrum, and the alveolus. At this point, sedimentation can occur on the fluid lining.

Table 1*

Particle Size (microns)	10	5	3.5	2.5	2
Respirable %	0	25	50	75	100

* Taken from Industrial Environmental Health, Cralley, L. V. et. al., p. 318, Academic Press, New York, 1972.

The dust inhaled with ability to become deposited upon the alveolar suffface has therefore been termed "respirable dust". In other words it is the dust that reaches the alveolus and is capable of causing

(1) Wolf, F. A., Occupational Diseases of the Lung Part II, Inhalation diseases due to inorganic dust, Ann. Allergy 35; p. 87-92, 1975.

(2) Morgan, W. K. C., and N. L. Lapp, Respiratory diseases of coal Miners, Am. Rev. Res. Dis. 113, p. 531-537, 1976.

lung pathology or a condition of "pneumoconiosis". Pneumosoniosis is a Greek derivation and means "lung dust'. It is a general term which refers to the deposition and retention of air-borne dust particles in the lung without regard to specific lung pathology. Various types of pneumoconiosis are recognized.

Silicosis pneumoconiosis or simply silicosis develops through the inhalation of crystalline-free silica dust. Since ten percent of the earth's surface is composed of quartz, crystalline-free silica is thereby an important constituent in all mining operations.[1]

Inhaled silica becomes deposited on the alveolar surface where it is phagotized by alveolar macrophages. The alveolar macrophage serves as the cleansing system of the lungs interior. There are conflicting reports on the next step in silicate toxicity.

One explanation states that silica is highly toxic to the roving macrophage cells. These cells die enroute to the lymph nodes. The dead cells become aggregated then finally are enveloped by fibrotic tissue.[2] A second proposal states that during breakdown of the crystalline silica by the body or by its dissolving, an acid is produced. This acid destroys the cells of the lung which try and entrap the particle. As a result, a scar is formed which makes the lung stiff so that it becomes more and more difficult to move air in and out.[3] A third possibility is that inhaled silica kills and lyses the macrophages to release an enzyme. This enzyme then stimulates fibroblast to produce collegen fibres. The result is a lesion of dead macrophages, dust and fiberous matter.[4]

Following the primary lesion the fibrotic tissue proliferates into the characteristic silicotic nodule. These nodules are small at first but then coalesce with continued inhalation of silica dust. The lungs gradually become filled with many of these nodules. Years after the initial stages but with continued growth of the nodules, normal lung function becomes hindered. The result is a condition of acute obstructive emphysema with a predisposition to tubercular infection.

Even at simple discrete nodules of hyaline fibrous tissue, no recognizable clinical manifestations exist.[5] This may continue for years. The first sign of silicosis is dyspnea but only upon exhertion. The disease may progress to distort and destroy the pulmonary structure. This structure change produces an increased circulatory resistance and may therefore cause cardiac failure.

The highest generation of silica occurs where narrow bands of strippable coal exists because more silica containing earth is likely to

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(1) Mayer, M. R., Occupational Health, The Williams and Wilkens Co., Baltimore, p. 41, 1969.

(2) Ibid., p. 254.

(3) Elmes, P. C., Occupational disease in road and building industry, Respiratory disease, Chemistry and Industry #21, p. 1022-1026, 1973.

(4) Morgan, W.K.C. and N. L. Lapp. Respiratory diseases of coal miners, Am. Rev. Res. Dis. 113, p. 531-537, 1976.

(5) Wolf, F.A., Occupational Diseases of the Lung Part II, Inhalation diseases due to inorganic dust, Ann. Allergy 35; p. 87-92, 1975.

be disturbed.[1] Silicate dust may also be generated by such mining operations as blasting, transportation on unpaved roads as well as overburden loading and unloading.

The silicosis hazard may be calculated as follows:[2]

$$\text{Respirable dust (mg/m}^3\text{)} = \frac{10}{(10)\ \%\ \text{RFS*}}$$

* % RFS = percent of free silica in dust

The upper limit of respirable dust has been set at 2.0 mg/m^3 [3]

The dangers of silicosis increases when the dust is just freshly generated and especially when the particle size is extremely small. This is true in the cases of dust generated through the mining processes of blasting and drilling. Other factors which influence the danger of silicosis are the combination with other particulates, duration of contact, worker's age and past history of respiratory function. Special attention must be noted that smoking has been shown to increase the rate of silicosis in miner's thirty times.[4]

COAL MINER'S PNEUMOCONIOSIS

Coal miners pneumoconiosis also called anthracosis, anthracosilicosis or best known as black lung is the result of inhaled coal dust high in carbon.[5] Silica is unimportant in the development of miner's pneumoconiosis. The dust becomes deposited around the bronchioles and arterioles of the respiratory surface. This deposition causes the development of a type of emphysema called "focal emphysema." This is the major disability attributed to black lung disease. Usually there is not much fibrotic tissue formation. Massive firbosis may form due to a secondary infection of tuberculosis. If fibrosis occurs symptoms are apt to progress despite changes in environment.

INDUSTRIAL BRONCHITIS

The third pulmonary disorder that earlier was mentioned was industrial bronchitis. This disease is characterized by increased cough, sputum and a decrease in the ventilatory capacity. Industrial bronchitis develops through inhalation of dusts over long periods of time.[6] The affected area is the upper respiratory track where dust irritation causes increased mucus production and inflamation.

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(1) Morgan, W.K.C. and N. L. Lapp. Respiratory diseases of coal miners, Am. Rev. Res. Dis. 113, p. 531-537, 1976.

(2) Cralley, L. V., Cralley, L. J., Clayton, G. D., and Jurgiel, J. A., Industrial Environmental Health, the Workers and the Community, Academic Press, New York and London, p. 320, 1972.

(3) Cralley, L. V., Cralley, L. J., Clayton, G. D., and Jurgiel, J. A., Industrial Environmental Health, the Workers and the Community. Academic Press, New York and London, p. 396, 1972.

(4) Ibid., p. 43.

(5) Wolf, F. A., Occupational Diseases of the Lung Part II, Inhalation diseases due to inorganic dust, Ann. Allergy 35; p. 87-92, 1975.

(6) Morgan, W.K.C. and Lapp, N. L., Respiratory diseases of coal miners, Am. Rev. Res. Dis. 113, p. 531-537, 1976.

MINING OPERATIONS AND THE SURROUNDING COMMUNITY

The effect of mining upon respiratory function is not always limited to the employed population, but has been shown to be reflected in the general population.

In a study of a metal mining community (where open-pit mining is the prevalent form) and a smelting community, it was observed that the incidence of lung carcinoma not only was elevated in the mining and smelting workers, but also among women who did not experience occupational exposure when compared to the rates in other cities.[(1)]

Although the toxic substance was not identified, the best explanation for this situation seems to be that the same agent which increased cancer among the men from occupational exposure also increased the cancer among the women. In the smelting city, air-borne arsenic, sulfur dioxide, and possibly nitrogen dioxide may be indicated as the causal factors.

In a separate study several communities, where underground coal mines are a prominent industry, provided statistics showing silicosis and black lung were clearly occupationally related.[(2)] Unexpectedly, however, the wives of the miners' reported more respiratory disorders than the wives of other workers. It stated, "If occupational factors are involved in any way in the reported cough, phleym, wheezing, and breathlessness; coal miner's wives seem to be nearly as effected by their husbands' occupation as husbands themselves". A possible explanation offered by the author is that chronic bronchitis contracted by the miners as the result of exposure to coal dust may have an infectious aspect in the bacteriological sense.

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(1) Newman, J. A., Archer, V. E., Saccomanno, G., et. al., Histologic types of Bronchogenic carcinoma among members of copper-mining and smelting communities, Ann. N.Y., Acad. Sci. 271; p. 260-268, 1976.

(2) Enterline, P., The Effect of Occupation on Chronic Respiratory Disease, Arch. Environmental Health 14, p. 189, 1967.

Appendix E-1. -- Subgroup classification of soil series recognized in the Spring Creek permit area and the dominant physiographic positions occupied

Soil Series	Subgroup and Family	Physiography and Parent Rocks
Colbar	Ustollic Camborthids: fine silty, mixed, mesic	Nearly level and gently sloping alluvial fans and terraces
Corkim	Ustollic Camborthids: fine loamy, mixed, mesic	Nearly level and gently sloping alluvial fans and terraces
Kimlen	Ustollic Camborthids: fine silty, mixed, mesic	Nearly level and gently sloping alluvial and colluvial fans and terraces, moderately deep to sedimentary bedrock.
Erlan	Aridic Haplustolls: coarse loamy, mixed, mesic	Fans and footslopes below ridges of scoria
Sperlin	Aridic Haplustolls: coarse loamy, mixed (calcareous), mesic	Moderately deep soils overlying scoria on the ridges and divides between stream valleys
Shinler	Ustic Torriorthents: fine silty, mixed (calcareous), mesic, shallow	Soils of the residual uplands shallow over sandstone, siltstone or shale
Travella	Lithic Ustic Torriorthents: loamy skeletal, mixed (calcareous), mesic	Shallow soils overlying hard sandstone occurring ridge crests and divides as well as on nearly level mesa tops
Wiberg	Ustic Torriorthents: fragmental, mixed (calcareous), mesic	Shallow soils of the uplands overlying scoria
Alluvial	Ustic Torriorthents (field classification)	Alluvium in floodplains

Appendix E-2. -- Profile descriptions of soil series in the Spring Creek Area

COLBAR SERIES

This series consists of deep, well drained, silty soils on fans. Typically, these soils have a grayish brown, silty clay loam surface, light yellowish brown, prismatic calcareous, silty clay loam subsoils and light yellowish brown silty clay loam and silt loam substratum.

Representative profile of Colbar silty clay loam in Section 24, T8S, R39E, 550 feet south and 660 feet east of W1/4 corner:

Ap--0 to 5 inches; grayish brown (2.5Y 5/2) dry, light silty clay loam, dark grayish brown (2.5Y 4/3) moist; strong very fine and fine granular structure; slightly hard when dry, very friable when moist, and slightly sticky but plastic when wet; weak effervescence.

B21-5 to 9 inches; light yellowish brown (2.5Y 6/4) dry, light silty clay loam; light olive brown (2.5Y 5/4) moist; moderate medium prismatic structure separating to moderate fine and medium blocks; hard when dry, very friable when moist, slightly sticky but plastic when wet; weak effervescence.

B22-9 to 15 inches; light yellowish brown (2.5Y 6/4) dry, light silty clay loam; light olive brown (2.5Y 5/4) moist; weak medium and coarse prismatic structure; hard when dry, very friable when moist, slightly sticky but plastic when wet; strong effervescence; few soft masses of segregated lime.

C1ca--20 to 31 inches; light yellowish brown (2.5Y 6/4) dry, heavy silt loam and light silty clay loam; light olive brown (2.5Y 5/4) moist; massive very hard when dry, very friable when moist, slightly sticky but plastic when wet; strong effervescence; few soft masses and threads of segregated lime.

C2--31 to 40 inches; light yellowish brown (2.5Y 6/4) dry, heavy silt loam and light silty clay loam; light olive brown (2.5Y 5/4) moist, stratified; hard when dry, very friable when moist, slightly sticky but plastic when wet; strong effervescence.

C3cs--40 to 78 inches; light yellowish brown (2.5Y 6/4) dry, light silty clay loam and heavy silt loam; light olive brown (2.5Y 5/4) moist; stratified; hard when dry, very friable when moist, slightyly sticky but plastic when wet; strong effervescence; few threads and seams of segregated gypsum.

C4--78 to 120 inches; light yellowish brown (2.5Y 6/3) dry, light silty clay loam and heavy silt loam; light olive brown (2.5Y 5/3) moist; stratified; hard when dry, very friable when moist, slightly sticky but plastic when wet; strong effervescence; few fine threads of visible silts below 96 inches.

Range in Characteristics: Depth to unweathered siltstone bedrock is 5½ to over 12 feet. The texture of 10 to 40-inch control section is silty clay loam or heavy silt loam with 25 to 35 percent clay and less than 15 percent fine and coarser sands. The solum is 18 to 26 inches thick. Colors are in hue of 2.5 Y or 10 YR.

The A horizon has colors with value of 5 or 6 dry and 4 or 5 moist and chromas of 2 or 3. The B horizons have weak or moderate grade of structure and have color with value of 5 or 6 dry and chromas of 3 to 5. The C horizons have few or no segregations of lime. Depth to gypsum is 36 to 50 inches.

CORKIM SERIES

This series consists of deep, well drained, loamy soils on fans and terraces. Typically, these soils have brown loam A horizons, brown prismatic loam B horizons, and loam Cca and C horizons.

Representative profile of Corkim loam in Section 24, T8S, R39 E, about 700 feet west of center of Section:

Ap--0 to 6 inches; brown (10YR 5/3) dry, light loam; brown (10 YR 4/3) moist; weak very fine and fine granular structure; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet.

B2--6 to 16 inches; brown (10YR 5/3) dry, light loam; brown (10YR 4/3) moist; moderate medium prismatic structure separating to moderate fine and medium blocks; hard when dry, very friable when moist, slightly plastic when wet; strong effervescence; few soft masses of segregated lime.

C2--36 to 78 inches; light olive brown (2.5Y 5/3) dry; very fine sandy loam, loam, silt loam, and fine sandy loam stratified; light olive brown (2.5Y 4/3) moist; hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; moderate effervescence. Texture of bulk is a light loam.

C3ca--78 to 96 inches; grayish brown (2.5Y 5/2) dry, very fine sandy loam, loam, silt loam, and fine sandy loam stratified; dark grayish brown (2.5Y 4/2) moist; moderate effervescence; few fine threads of segregated gypsum. Texture of bulk is a light loam.

C4--96 to 120 inches; grayish brown (2.5Y 5/2) dry, very fine sandy loam stratified with thin lenses of loam, silt loam, and fine sandy loam; dark grayish brown (2.5Y 4/2) moist; weak effervescence.

Range in Characteristics: Depth to bedrock is more than 8 feet. Texture of the 10- to 40-inch control section is loam or silt loam with less than 15 percent clay and more than 15 percent coarser than very fine sand. Colors are dominantly in the 2.5Y or 10YR hues, but include 7.5YR and 5YR hues in some profiles.

The A horizon has colors with value of 5 dry and 4 moist and chroma of 2 or 3. The B horizons have weak or moderate grades of structure. The segregated lime is absent in some pedons. Thickness of noncalcareous part of the soil is 4 to 16 inches. The lower C horizons below 7 feet contain varying amounts of rock fragments in some places.

ERLAN SERIES

This series consists of deep, well drained, red colored, loam soils formed in alluvium of fans and foot slopes. Typically, these soils have reddish brown loam A and B horizons and yellowish red slaty and channery loam C horizons.

Representative profile of Erlan slightly slaty loam in Section 31, T8S, R40E, about 1,575 feet west and 775 feet south of NE section corner:

A1--0 to 8 inches; reddish brown (5YR 5/3) dry, light loam; dark reddish brown (5YR 3/4) moist; weak fine and medium granular structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; about 10 percent by volume of very fine and fine flat porcelanite fragments.

B2--8 to 20 inches; reddish brown (5YR 5/3) dry, slaty light loam; dark reddish brown (5YR 3/4) moist; weak very fine and fine subangular blocky structure; soft when dry, very friable to loose when moist, nonsticky and nonplastic when wet; about 15 percent by volume of very fine and fine flat porcelanite fragments; weak effervescence in upper and moderate effervescence in low part.

C1--20 to 44 inches; yellowish red (5YR 5/6) dry, slaty light loam; yellowish red (5YR 4/6) moist; nonsticky and nonplastic when wet; about 25 to 30 percent by volume of porcelanite and fused sandstone fragments, mainly less than 1 inch in size but with a few up to 6 inches across; weak effervescence; lime crusts on undersides of larger fragments.

C3--60 to 84 inches; yellowish red (5YR 5/6) dry, slaty light loam; yellowish red (5YR 4/6) moist; massive; soft to loose when dry, very friable to loose when moist, nonsticky and nonplastic when wet; about 35 percent by volume of flat porcelanite and sandstone fragments, mainly less than 1 inch in size; weak effervescence.

C4--84 to 108 inches; yellowish red (5YR 5/6) dry, slaty and channery fine sandy loam; yellowish red (5YR 4/6) moist; massive; loose when dry and moist, nonsticky and nonplastic when wet; about 25 percent by volume of flat porcelanite and sandstone fragments; strong effervescence.

Range in Characteristics: Depth to bedrock is 6 feet to over 10 feet. Texture of the 10- to 40-inch control section is loam or very fine sandy loam with less than 5 percent clay and 15 to 35 percent by volume or rock fragments. Colors are in 5YR to 10R hue.

The A horizon has color with value of 5 dry and 3 or 4 moist and chroma of 3 or 4. The B horizon has a weak grade of structure and color with value of 5 dry and 3 or 4 moist and chroma of 3 to 5.

KIMLEN SERIES

This series consists of deep, well drained, silty soils formed in materials weathered in place from the underlying siltstone bedrock or in alluvium deposited on these geologic beds. Typically, these soils have grayish brown, silty clay loam A horizons; light olive brown silty clay loam B2 horizons, and light yellowish brown, calcareous, silt loam B3 and C horizons underlain by unweathered siltstone at about 48 inches.

Representative profile of Kimlen silty clay loam in Section 31, T8S, R40E, about 500 feet west of the center of the Section.

A1--0 to 4 inches; light brownish gray (2.5Y 5/3) dry, light silty clay loam; grayish brown (2.5Y 4/3) moist; moderate thin and moderately thick platy structure separating to moderate fine granules; hard when dry, very friable when moist, sticky and slightly plastic when wet.

B21--4 to 8 inches; light olive brown (2.5Y 5/4) dry, silty clay loam, olive brown (2.5Y 4/4) moist; moderate medium prismatic structure separating to moderate fine and medium blocks; hard when dry, very friable when moist, sticky and slightly plastic when wet.

B22--8 to 16 inches; light olive brown (1.5Y 5/4) dry, light silty clay loam, olive brown (2.5Y 4/4) moist; moderate medium prismatic structure separating to moderate fine and medium blocks; hard when dry, very friable when moist, sticky and slightly plastic when wet; weak effervescence.

B3ca--16 to 22 inches; light yellowish brown (2.5Y 6/4(dry, light silty clay loam, light olive brown (2.5Y 5/4) moist; weak medium and coarse prismatic structure separating to weak medium and coarse blocks; hard when dry, very friable when moist, sticky and slightly plastic when wet; strong effervescence; few soft masses of segregated lime.

C1ca--22 to 34 inches; light yellowish brown (2.5Y 6/4) dry, heavy silt loam; light olive brown (2.5Y 5/4) moist; massive; hard when dry, very friable when moist, sticky and slightly plastic when wet; strong effervescence; common soft masses of segregated lime.

IIC2--34 to 46 inches; weathered siltstone bedrock.

IIC3r--46 to 60 inches; unweathered platy siltstone bedrock.

Range in Characteristics: Depth to the unweathered sedimentary bedrock is between 42 to 66 inches. The texture of the 10- to 40-inch control section is dominantly silty clay loam with 27 to 35 percent clay but includes heavy silt loam with more than 24 percent clay. Noncalcareous part of the profile is 0 to 8 inches thick. Colors are mainly in the 2.5Y hue.

The A horizon has value of 5 or 6 dry and 4 moist. The B2 horizons have weak or moderate grades of structure and have colors with value of 5 or 6 dry and 4 or 5 moist and chroma of 2 to 4. It has weak to strong effervescence. Few or no soft masses of segregated lime are present in the B3ca horizon.

SHINLER SERIES

This series consists of shallow loamy soils formed in residuum weathered from the underlying weakly or moderately consolidated loamstones or siltstones of the Fort Union geological formation. Typically, these soils have grayish brown silt loam A horizons and pale olive silt loam C horizons underlain by platy siltstone within a depth of 20 inches.

Representative profile of Shinler silty clay loam in Section 27, T8S, R39E, 950 feet south and 1700 feet west of NE section corner, just above road:

A1--0 to 4 inches; grayish brown (2.5Y 5/2) dry, light silty clay loam, grayish brown (2.5Y 4/3) moist; weak very fine granular structure; soft when dry, very friable when moist, nonsticky and slightly plastic when wet; weak effervescence.

C1--4 to 10 inches; pale olive (5Y 6/3) dry, light silty clay loam; olive (5Y 5/3) moist; weak coarse prismatic structure; hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; strong effervescence.

C2--10 to 16 inches; variegated olive colored materials of light silty clay loam texture, about 50 percent by volume of mass consists of plates of siltstone that are hard and brittle when dry; strong effervescence. This is the weathered siltstone!

C3r--16 to 32 inches; platy siltstone that rubs to a silty clay loam texture; few roots between plates in upper few inches.

Range in Characteristics: Depth of soil over relatively unweathered sedimentary beds is 4 to 20 inches. Texture of the weathered regolith is loam, silt loam, or silty clay loam with 12 to 35 percent clay. Soft masses of segregated lime or of gypsum are present in some pedons. Colors are in hues of 5Y through 10YR.

SPERLIN SERIES

This series consists of moderately deep, red colored, loam soils formed in residuum weathered from the underlying moderately consolidated or indurated porcelanite or baked sandstone bedrock. Typically, these soils have reddish brown loam A horizons and red loam C and Cca horizons underlain by hard porcelanite or fused sandstone at about 26 inches.

Representative profile of Sperlin loam in Section 19, T8S, R40E, about 1000 feet north and 200 feet east of the center of the section.

A1--0 to 3 inches; reddish brown (2.5YR 5/3) dry, loam, reddish brown (2.5YR 4/4) moist; weak very fine and fine granular structure; soft when dry, very friable when moist, slightly sticky and nonplastic when wet; weak effervescence.

C1--3 to 12 inches; red (2.5YR 5/5) dry, loam; red (2.5YR 4/6) moist; weak coarse prismatic structure separating to weak fine and medium subangular blocks; slightly hard when dry, very friable when moist, slightly sticky and nonplastic when wet; moderate effervescence; few very fine and fine porcelanite fragments.

C2--12 to 20 inches; red (2.5YR 5/6) dry, loam, red (2.5YR 4/6) moist; weak medium and coarse blocky structure; slightly hard when dry, very friable when moist, slightly sticky and nonplastic when wet; moderate effervescence; few fine sandstone and porcelanite fragments.

C3ca--20 to 26 inches; light red (2.5YR 6/6) dry, loam; red (2.5YR 5/6) moist; massive; slightly hard when dry, very friable when moist; slightly sticky and nonplastic when wet; strongly effervescent; few sandstone and porcelanite fragments with lime on undersides.

R--26 to 36+ inches; fractured and shattered sandstone which is partially weathered in upper 6 inches.

Range in Characteristics: Depth to partially weathered porcelanite and/or sandstone is 20 to 30 inches, and to unweathered bedrock 24 to 40 inches. The texture of the control section (10 inches to bedrock) is very fine sandy loam, loam, or silt loam with less than 10 percent clay

and less than 15 percent by volume of rock fragments larger than 2mm in size. Colors are in hue of 5YR through 10R.

The A1 horizon has value of 5 dry and 3 or 4 moist and chroma of 3 or 4. The C horizon has value of 5 or 6 dry and 4 moist and chroma of 4 to 6.

The underlying bedrock consists mainly of shattered and fractured porcelanite and fused sandstone but may be buff colored, hard sandstone in some places. The upper 4 to 8 inches is partially weathered but contains less than 10 percent by volume of fines. Below this weathered upper part the unweathered bedrock may be fractured and shattered or unfractured but it forms a continuous phase at least 4 inches between vertical fractures.

TRAVELLA SERIES

This series consists of shallow and very shallow soils underlain by hard sandstone within 5 inches. Typically, these soils have grayish brown very channery loam A horizons and brown very channery loam C horizons underlain by hard sandstone within 10 inches.

Representative profile of Travella very channery loam in Section 22, T8S, R39E, about 1,000 feet north and 1,200 feet west of E¼ corner:

A1--0 to 2 inches; grayish brown (10YR 4/3) dry, very channery light loam, brown (10YR 4/3) moist; weak fine and very fine granular structure; soft when dry, very friable when moist, nonsticky and non plastic when wet.

C--2 to 5 inches; brown (2.5Y 5/3) dry, very channery light loam, dark brown (10YR 4/3) moist; massive; soft when dry, very friable when moist, nonsticky and nonplastic when wet; about 50 percent by volume of sandstone fragments.

R--5+ inches; hard sandstone.

Range in Characteristics: Depth to hard sandstone is 2 to 10 inches. Texture of the regolith is loam or fine sandy loam with more than 50 percent by volume of rock fragments.

WIBERG SERIES

This series consists of shallow, red colored, loamy soils over shattered and fractured porcelanite and fused sandstone. Typically, these soils have weak red loam A horizons and red loam C horizons underlain by fractured scoria or fused sandstone within 10 inches.

Representative profile of Wiberg loam in Section 30, T8S, R40E, about 250 feet south and 200 feet west of E¼ corner.

A1--0 to 2 inches; weak red (10R 5/4) dry, light loam; weak red (10YR 4/4) moist; weak very fine and fine granular structure; soft when dry, very friable when moist, slightly sticky and non plastic when wet; about 5 percent by volume of fine porcelanite fragments.

C1--2 to 10 inches; red (10R 5/6) dry, light loam; red (10R 4/6) moist; weak very fine to medium granular structure; soft when dry; very friable when moist, slightly sticky and slightly plastic when wet; moderate effervescence; few fine porcelanite fragments.

R1--10 to 19 inches; partially weathered, fractured and shattered porce lanite and fused sandstone with less than 5 percent by volume of fines mainly in fractures and between horizontal bedding planes; strong effervescence; lime crusts on both upper and lower surfaces of fragments.

R2--19 to 24+ inches; consolidated porcelanite and baked sandstone which is somewhat fractured and shattered.

Range in characteristics: Depth to fractured and shattered bedrock is 4 to 16 inches. Texture of the regolith is very fine sandy loam, loam, or silt loam with less than 5 percent clay and 5 to over 50 percent rock fragments. Colors are in hues of 5YR through 10R.

2 Alluvial lands, loamy

This unit is on the flood plains and low bottomlands within the narrow intermittent stream valleys. It is a miscellaneous land type consisting of several different kinds of soils of varying textures and ranging from less than 20 inches to over 84 inches to sand and gravel. Strata consisting of sand or sand and gravel occur at any depth, but usually below 24 inches, in many places. Some areas of clayey and sandy or gravelly soils occur in some places. Small areas less than one acre in size of wet or wet and saline soils are included.

The soils in this mapping unit have been dissected to varying degrees by stream channels. They may or may not be subject to overflow and depositions of fresh material during periods of high runoff.

In places, the vertical sidewalls flanking the stream valley are included within a delineation.

Areas up to two acres in size are without deep channels.

APPENDIX E-3

SOIL CHEMISTRY

Series	Depth (in.)	pH (paste)	E.C. (mmhos/cc)	Saturation %	Ca (meq/L extract	Mg (meq/L extract	Na (meq/L extract	SAR	Boron (ppm)	Particle Size Distribution % SN	% VFS	% SI	% CL	Textural Class
Kimlen	0-6	8.2	1.7	71.8	12.5	1.9	3.9	1.5	0.4	5	21	39	35	CLm-SiCLm
	6-16	8.3	2.8	66.1	14.4	2.3	8.3	2.9	0.5	5	24	63	8	SiLm-Si
	16-22	7.9	5.2	55.2	28.8	14.5	10.0	2.2	0.4	6	21	61	21	SiLm
	22-34	7.9	5.3	52.8	26.5	19.3	11.3	2.4	0.4	5	26	55	14	SiLm
	34-48	8.0	14.2	65.0	22.9	77.8	29.5	4.2	0.4	7	28	64	1	SiLm-Si
	48-60+	6.9	19.4	74.3	19.0	143.6	18.6	2.1	0.4	26	16	37	21	Lm
Shinler	0-5	8.9	2.2	71.5	7.0	2.7	9.9	4.5	0.3	4	12	56	28	SiCLm
	5-10	9.2	3.5	85.2	7.0	3.0	21.8	9.7	0.1	4	12	54	30	SiCLm
	10-15	9.2	4.1	79.4	8.2	3.4	33.7	14.0	0.4	4	11	54	31	SiCLm
	15-30+	8.7	12.3	85.4	6.0	13.7	87.7	22.7	0.1	4	13	51	32	SiCLm
Shinler	0-4	8.4	1.7	67.1	10.4	3.0	3.9	1.5	0.5	3	9	56	32	SiCLm
	4-10	8.2	1.7	69.6	8.6	2.5	4.4	1.8	0.5	3	8	58	31	SiCLm
	10-16	8.5	0.9	76.2	17.0	2.6	3.5	2.0	0.5	3	9	53	35	SiCLm
	16-32	8.9	1.1	83.8	2.7	1.9	6.9	4.5	0.6	3	11	53	33	SiCLm
Sperlin	0-3	8.1	2.3	53.3	13.1	1.9	6.2	2.3	0.3	31	20	38	11	Lm
	3-20	8.2	2.3	58.0	9.5	2.6	7.6	3.1	0.3	31	22	37	10	FSLm-Lm
	20-38	8.3	13.2	41.0	33.9	69.1	32.2	4.5	0.7	29	19	40	12	Lm
Sperlin	0-3	7.7	1.5	70.2	7.8	1.8	5.6	2.5	0.4	39	18	37	6	FSL
	3-20	8.2	3.1	71.8	21.5	3.2	6.8	1.9	0.4	38	17	40	5	FSLm
	20-34	8.8	5.6	60.7	14.0	8.4	26.5	7.9	0.7	36	19	41	4	FSLm
	34-40	8.8	4.9	63.3	15.0	10.4	28.0	7.9	0.7	35	18	42	5	FSLm
Travella	0-5	8.3	2.3	72.9	10.3	1.7	6.7	2.7	0.4	5	30	35	20	Lm
Travella	0-5	7.7	1.8	58.8	10.2	2.4	4.0	1.6	0.5	15	29	42	14	Lm
Wiberg	0-6	7.5	2.4	60.4	14.1	3.9	4.9	1.6	0.3	32	18	40	10	Lm
	6-24	8.3	2.3	59.2	13.5	4.9	5.2	1.7	0.6	32	19	42	7	Lm
Wiberg	0-2	7.7	1.9	68.2	9.5	2.7	4.3	1.7	0.3	25	16	41	18	Lm
	2-10	8.2	2.0	64.9	9.2	3.1	6.1	2.4	0.6	29	17	42	12	Lm

APPENDIX E-3

SOIL CHEMISTRY

Corkim	0-6	7.6	2.1	68.7	11.6	6.8	5.2	1.7	0.3	3	9	50	38	SiCLm
	6-16	8.1	1.2	74.7	5.4	3.3	3.0	1.4	0.3	21	27	36	16	Lm
	16-36	8.7	1.0	79.2	3.2	4.5	2.5	1.3	.05	11	19	36	34	CLm
	36-56	9.2	1.6	54.3	2.8	6.9	5.2	2.4	0.8	12	22	37	29	CLm
	56-78	8.5	9.3	51.4	32.8	55.1	9.2	1.4	0.3	14	31	37	18	Lm
	78-96	8.4	11.4	47.5	34.1	59.6	9.1	1.3	0.2	12	27	37	24	Lm
	96-120	8.3	9.5	49.8	28.4	46.9	12.3	2.0	0.1	14	29	37	20	Lm
Corkim	0-6	7.5	1.4	70.0	4.3	3.5	3.3	1.7	0.5	26	14	42	18	Lm
	6-12	8.2	1.2	73.1	5.5	3.0	3.6	1.8	0.4	28	13	43	16	Lm
	12-27	8.6	1.6	52.0	5.8	4.5	4.1	1.8	0.3	25	13	45	17	Lm
	27-46	8.9	1.7	49.0	4.1	8.5	3.8	1.5	0.4	28	12	45	15	Lm
	46-56	9.0	2.3	39.0	3.8	10.7	6.8	2.5	0.7	26	13	44	17	Lm
	56-73	8.8	2.3	40.7	6.1	13.5	5.2	1.7	0.6	37	39	16	8	VFSLm
	73-96	8.7	3.7	34.5	7.2	15.2	7.9	2.3	0.4	37	36	18	9	FSLm-VFSLm
Erlan	0-6	7.6	1.2	61.5	6.4	2.0	3.7	1.8	0.4	41	31	22	6	FSLm
	6-20	8.3	4.0	50.7	21.7	3.0	9.4	2.7	0.6	42	33	21	4	LFS-FSLm
	20-34	8.3	2.6	45.9	13.1	4.9	10.4	3.5	0.4	40	35	23	5	FSLm
	34-44	8.5	3.4	44.5	15.7	3.7	13.3	4.3	0.4	42	32	21	5	FSLm
	44-60	8.5	3.4	42.6	16.4	4.7	16.1	5.0	0.4	31	37	27	5	VFSLm
	60-84	8.5	3.1	45.2	17.7	3.9	12.9	3.9	0.5	32	39	25	4	VFSLm
	84-108	8.5	4.8	42.4	20.0	5.3	13.3	4.3	0.4	31	41	24	4	VFSLm
Erlan	0-6	7.7	2.0	67.3	7.4	4.2	3.9	1.6	0.1	32	17	43	8	Lm
	6-14	8.2	1.3	66.5	7.5	2.9	3.7	1.6	0.2	29	18	44	9	Lm
	14-28	8.4	2.1	54.5	11.9	5.2	5.7	2.0	0.4	30	17	46	7	Lm-FSLm
	28-43	8.6	1.8	54.7	7.3	5.3	6.7	2.6	0.7	31	19	44	6	FSLm
	43-58	8.7	2.7	49.0	8.2	6.3	9.7	3.6	0.9	23	14	46	17	Lm
	58-74	8.4	4.3	51.4	9.7	21.1	13.3	3.4	1.0	26	16	46	12	Lm
	74-96	8.3	7.2	54.5	22.9	33.6	17.2	3.2	0.8	32	17	41	10	Lm
Kimlen	0-6	8.5	1.8	61.8	8.1	4.7	4.2	1.7	-0.1	9	27	40	24	Lm
	6-14	8.6	2.0	70.9	7.8	5.8	3.4	1.3	0.2	13	25	36	26	Lm
	14-24	9.3	1.1	65.3	3.1	3.3	4.8	2.7	-0.1	7	27	38	28	CLm
	24-34	8.6	7.8	68.8	14.2	41.2	22.9	4.3	0.2	7	23	37	33	CLm
	34-50	8.4	17.4	68.5	22.3	113.1	41.2	5.0	-0.1	8	24	36	32	CLm
	50-58	3.2	19.0	76.7	22.0	108.6	48.0	5.9	-0.1	8	21	37	34	CLm
	58-72	8.1	12.7	76.0	18.8	78.9	45.7	6.5	-0.1	6	20	38	36	CLm

APPENDIX E-3
SOIL CHEMISTRY

Series	Depth (in.)	pH (paste)	E.C. (mmhos/cc)	Saturation %	Ca (meq/L extract	Mg (meq/L extract	Na (meq/L extract	SAR	Boron (ppm)	Particle Size Distribution % SN	% VFS	% SI	% CL	Textural Class
Colbar	0-6	8.1	3.3	66.6	16.5	7.5	12.3	3.5	0.4	13	28	47	12	Lm
	6-11	8.7	2.3	68.7	10.9	6.4	3.8	1.3	0.5	3	17	52	28	SiCLm
	11-21	8.7	4.1	67.5	20.9	11.6	7.0	1.7	0.5	3	15	50	32	SiCLm
	21-34	8.5	14.0	56.2	29.0	83.9	17.8	2.4	0.5	8	24	43	25	Lm
	34-54	8.6	16.2	69.3	22.4	114.5	29.2	3.5	0.5	10	24	39	27	CLm
	54-78	8.7	14.7	70.4	23.9	90.6	47.5	6.3	0.5	11	26	37	26	Lm
	78-100	8.8	13.5	69.7	15.1	60.4	46.5	7.6	0.3	7	25	38	30	CLm
	100-120	9.0	7.5	77.6	14.8	33.3	24.5	5.0	0.6	11	25	36	28	CLm
Colbar	0-6	8.6	2.3	63.7	10.2	4.2	8.0	3.0	0.6	10	28	35	27	CLm-Lm
	6-18	9.1	5.6	69.6	20.8	22.7	7.6	1.6	0.3	12	21	38	29	CLm
	18-32	9.1	4.1	69.6	5.7	15.6	17.4	5.3	0.4	5	16	46	33	SiCLm
	32-50	8.5	10.9	71.9	21.3	46.4	42.2	7.2	-0.1	5	11	46	38	SiCLm
	50-68	8.6	8.5	59.5	15.1	30.8	40.4	8.4	-0.1	5	13	46	36	SiCLm
	68-84	8.7	9.1	73.0	12.3	25.1	42.9	9.9	0.1	2	2	48	48	SIC
Colbar	0-6	8.2	2.6	68.5	9.5	7.2	9.1	3.2	-0.1	14	27	43	16	Lm
	6-15	8.6	1.1	75.3	4.6	3.8	2.5	1.2	0.2	4	14	48	34	SiCLm
	15-31	9.2	1.5	62.2	3.2	5.0	5.2	2.6	0.2	11	21	37	31	CLm
	31-40	8.5	6.7	67.2	11.2	31.0	17.3	3.8	-0.1	11	22	35	32	CLm
	40-52	8.6	6.0	61.4	7.3	28.5	23.0	5.4	-0.1	11	20	40	29	CLm
	52-61	8.6	7.5	75.8	5.3	29.7	29.6	7.1	-0.1	4	14	46	36	SiCLm
	61-78	8.7	7.1	75.8	5.3	33.0	26.8	6.1	-0.1	3	7	50	40	SiC-SiCLm
	78-96	8.6	7.0	76.9	5.2	23.8	35.7	9.4	-0.1	11	20	41	28	CLm
	96-120	8.8	8.1	65.6	9.1	35.6	24.9	5.3	0.2	11	22	40	47	CLm-Lm
Colbar	0-6	8.1	3.5	62.5	22.4	9.7	6.3	1.6	0.4	22	15	34	29	CLm
	6-16	8.5	1.7	69.4	10.1	4.7	4.6	1.7	0.4	23	15	35	27	CLm-Lm
	16-32	9.1	1.2	71.7	2.5	2.3	8.3	5.3	0.5	10	19	35	36	CLm
	32-50	8.8	7.4	60.0	13.3	37.2	27.7	5.5	0.6	11	21	35	33	CLm
	50-70	8.6	12.6	56.0	28.6	71.1	26.1	3.7	0.4	12	23	35	30	CLm
	70-84	8.5	14.0	64.2	24.1	59.7	40.2	6.2	0.3	14	23	36	27	CLm-Lm
	84-100	8.6	15.0	59.8	24.5	69.7	41.1	6.0	0.3	16	26	35	23	Lm

Appendix F-1. -- Complete plant species list

TREES

Acer negundo	Box-elder
Fraxinus americana l.	White ash
Juniperus scopulorum Sarg.	Rocky Mountain juniper
Pinus Flexilis James	Limber pine
Pinus pondersoa Dougl.	Western yellow pine
Populus deltoides marsh.	Great Plains poplar
Prunus virginiana L. Var. melanocarpa (Nels.) Sarg.	Common chokecherry
Salix bebbiana Sarg. var. bebbiana	Bebb willow
Salix exigua Nutt. ssp. interior (Rowlee) Crong.	Sandbar willow
Salix lasiandra Benth.	Black willow

SHRUBS

Artemisia cana Pursh	Silver sagebrush
Artemisia tridentata Nutt.	Big sagebrush
Atriplex confertifolia (Torr. & Frem.) Wats.	Shadscale
Atriplex nuttallii Wats. var. nuttallii	Saltsage
Chrysothamnus nauseosus(Pall.) Britt. var. nauseosus	Common rabbit-bush
Cartaegus columbiana Howell var. columbiana	Columbia hawthorn
Eurotia lanata (Pursh) moq.	Winterfat
Juniperus horizontalis moench	Creeping juniper
Rhus radicans L.	Poison ivy
Rhus trilobata Nutt.	Skunkbush
Ribes aureum Pursh	Golden currant
Ribes cereum Dougl. var. inebrians (Lindl.) Hitchc.	Squaw currant
Ribes setosum Lindl.	Missouri gooseberry
Rosa arkansana Porter	Prairie rose
Sarcobatus vermiculatus (Hook.) Torr.	Black greasewood
Symphoricarpos albus (L.) Blake	Common snowberry

HERBS

Achillea millefolium L. ssp. lanulosa (Nutt.) Piper var. lanulosa	Common yarrow
Agoseris glauca (Pursh) Raf.	Pale agoseris
Allium textile Nels. & Macbr.	Textile onion
Alyssum alyssoides L.	Pale alyssum
Alyssum desertorum Stapf	Desert alyssum
Ambrosia artemisiifolia L.	Annual ragweed
Ambrosia psilostachya DC.	Western ragweed
Antennaria dimorpha (Nutt.) T. & G.	Low pussy-toes
Antennaria parvifolia Nutt.	Nuttall's pussy-toes
Apocynum androsaemifolium L. var. pumilum Gray	Spreading dogbane
Arabis holboellii Hornem. var. retrofracta (Grah.) Rydb.	Holboell's rockcress

HERBS (cont.)

Arenaria hookeri Nutt.	Hooker's sandwort
Arnica fulgens Pursh	Orange arnica
Artemisia biennis Willd.	Biennial wormwood
ssp. borealis (Pall.) Hall & Clem.	
var. scouleriana (Bess.) Cronq.	Pacific sagebrush
Artemisia dracunculus L.	Tarragon
Artemisia frigida Willd.	Fringed sagebrush
Artemisia ludoviciana Nutt.	
var. Ludoviciana	Western mugwort
Asclepias speciosa Torr.	Showy milkweed
Asclepias verticilliata L.	
*Aster Falcatus Lindl.	Creeping white prairie aster
Aster pansus (Blake) Cronq.	Tufted white prairie aster
Astragalus adsurgens Hook.	Standing milk-vetch
Astragalus agrestis Dougl.	Field milk-vetch
Astragalus aretioides (Jones) Barneby	
Astragalus bisulcatus (Hook.) Gray	Two-groove milk-vetch
Astragalus cibarius Sheld.	Browse milk-vetch
Astragalus crassicarpus Nutt.	Buffalo plum
Astragalus drummondii Hook.	Drummond's milk-vetch
Astragalus geyeri Gray	Geyer's milk-vetch
Astragalus gilviflorus Sheld	Plains orophaca
Astragalus gracilis Nutt.	Slender milk-vetch
Astragalus missouriensis Nutt.	Missouri milk-vetch
Astragalus purshii Dougl. var. purshii	Woolly-pod milk-vetch
Astragalus spatulatus Sheld.	Draba milk-vetch
Balsamorhiza sagittata (Pursh) Nutt.	Arrowleaf balsamroot
Besseya wyomingensis (A. Nels.) Rydb.	Wyoming besseya
Calochortus nuttallii T. & G.	Sego-lily
Camelina microcarpa Andrz.	Littlepod falseflax
Campanula rotundifolia L.	Lady's thimble
Castilleja sessiliflora Pursh	Downy painted-cup
Cerastium arvense L.	Field chickweed
Chaenactis douglasii (Hook.) H. & A.	
var. achilleaefolia (H. & A.) A. Nels.	Hoary false-yarrow
Chenopodium album L.	Lambsquarters
Chenopodium fremontii Wats. var. fremontii	Fremont's goosefoot
Chenopodium leptophyllum (Moq.) Wats.	
var. oblongifolium Wats.	Slimleaf goosefoot
Chorispora tenella (Pall.) DC.	Blue mustard
Chrysopsis villosa (Pursh) Nutt.	
var. foliosa (Nutt.) D.C. Eat.	Hairy golden-aster
Chrysopsis villosa (Pursh) Nutt.	
var. hispida (Hook.) Gray	Hairy golden-aster
Cirsium arvense (L.) Scop.	
var. horridum Wimm. & Grab.	Canada thistle
Cirsium undulatum (Nutt.) Spreng.	Wavy-leaved thistle

Cirsium vulgare (Savi) Tenore	Bull thistle
Clematis ligusticifolia Nutt.	Western Clematis
Cleome serrulata Pursh	Rocky Mountain bee plant
Collinsia parviflora Lindl.	Small-flowered blue-eyed Mary
Collomia lineris Nutt.	Narrow-leaf collomis
Comandra umbellata (L.) Nutt. var. pallida (DC.) Jones	Bastard toad-flax
Convolvulus arvensis L.	Field morning-glory
Coryphantha missouriensis (Sweet) Britt. & Rose	Nipple coryphantha
Crepis modocensis Greene ssp. modocensis	Siskiyou hawksbeard
Cryptantha affinis (Gray) Greene	Slender cryptantha
Cryptantha celosioides (Eastw.) Pays.	Cockscomb cryptantha
Cymopterus acaulis (Pursh) Raf.	Plains cymopterus
Delphinium bicolor Nutt.	Montana larkspur
Descurainia richardsonii (Sweet) Schulz var. viscosa (Rydb.) Peck	Mountain tansymustard
Descurainia sophia (L.) Webb	Flixweed
Dodecatheon conjugens Greene var. conjugens	Desert shooting star
Echinacea pallida Nutt. var. angustifolia (DC.) Cronq.	Pale purple coneflower
Ellisia nyctelea L.	Nyctelea
Epilobium glandulosum Lehm. var. tenue (Trel.) Hitchc.	Common willow-herb
Erigeron compositus Pursh var. glabratus Macoun	Cut-leaved daisy
Erigeron divergens T. & G.	Spreading fleabane
Erigeron ochroleucus Nutt. var. ochroleucus	Buff fleabane
Erigeron pumilus Nutt. ssp. pumilus	Shaggy fleabane
Eriogonum annuum Nutt.	Annual buckwheat
Eriogonum flavum Nutt. var. flavum	Yellow buckwheat
Eriogonum pauciflorum Pursh var. pauciflorum	Few-flowered buchwheat
Erysium asperum (Nutt.) DC.	Rough wallflower
Erysimum inconspicuum (Wats.) MacM.	Small wallflower
Euphorbia glyptosperma Engelm.	Corrugate-seeded spurge
Euphorbia robusta (Engelm.) Small	Rocky Mountain spurge
Evolvulus nuttallianus R. & S.	
Fritillaria pudica (Pursh) Spreng.	Yellow bell
Gaillardia aristata Pursh	Blanket-flower
Galium aparine L.	Goose-grass
Gaura coccinea (Nutt.) Pursh	Butterfly-weed
Geum triflorum Pursh var. triflorum	Prairie smoke
Gilia congesta Hook. var. congesta	Ballhead gilia
Glycyrrhiza lepidota Pursh var. lepidota	Licorice
Gnaphalium palustre Nutt.	Lowland cudweed
Grindelia squarrosa (Pursh) Dunal var. quasiperennis Lunell	Resin-weed
Gutierrezia sarothrae (Pursh) Britt. & Rusby	Broom snakeweed

HERBS (cont.)

Haplopappus armerioides (Nutt.) Gray	Thrift goldenweed
Haplopappus spinulosus (Pursh) DC.	Spiny goldenweed
Hedeoma hispida Pursh	Rough pennyroyal
Helianthus annuus L.	Common sunflower
Helianthus petiolaris Nutt.	Prairie sunflower
Hymenopappus filifolius Hook. var. polycephalus (Osterh.) Turner	Columbia cut-leaf
Iva xanthifolia Nutt.	Tall marsh-elder
Kuhnia eupatorioides L. var. corymbulosa T. & G.	False-boneset
Lactuca pulchella (Pursh) DC.	Blue Lettuce
Lactuca serriola L.	Prickly lettuce
Lappula echinata Gilib.	Bristly stickseed
Lappula redowskii (Hornem.) Greene var. cupulata (Gray) M.E. Jones	Western stickseed
Lappula redowskii (Hornem.) Greene var. redowskii	Western stickseed
Lathyrus bijugatus White	Pinewoods peavine
Lepidium densiflorum Schrad. var. densiflorum	Prairie peppergrass
Lesquerella alpina (Nutt.) Wats. var. leavis (Pays.) Hitchc.	Alpine bladderpod
Lesquerella ludoviciana (Nutt.) Wats. var. arenosa (Richards.) Wats.	Silvery bladderpod
Leucocrinum montanum Nutt.	Sand lily
Liatris punctata Hook.	Blazing-star
Linum perenne L. var. lewisii (Pursh) Eat. & Wright	Blue flax
Linum rigidum Pursh	Yellow flax
Lithospermum incisum Lehm.	Yellow gromwell
Lomatium orientale C. & R.	Eastern lomatium
Lupinus argenteus Pursh var. argenteus	Silvery lupine
*Lychnis apetala L.	Apetalous campion
Lychnis drummondii (Hook.) Wats.	Drummond campion
Lygodesmia juncea (Pursh) D. Don	Rush-like skeltonweed
Machaeranthera canescens (Pursh) Gray	Hoary aster
Machaeranthera grindelioides (Nutt.) Keck & Cronq.	Nuttall goldenweed
Machaeranthera tanacetifolia (H.B.K.) Nees	Tansy aster
Medicago lupulina L.	Black medic
Medicago sativa L.	Alfalfa
Melilotus alba Desr.	White sweet-clover
Melilotus officinalis (L.) Lam.	Common yellow sweet-clover
Mentzelia albicaulis Dougl.	White-stemmed mentzelia
Mentzelia decapetala (Pursh) Urb. & Gilg	Evening star
Mentzelis dispersa Wats.	Bushy mentzelia
Mertensia oblongifolia (Nutt.) G. Don	Leafy bluebells
Microseris troximoides Gray	False-agoseris
Microsteris gracilis (Hook.) Greene var. humilior (Hook.) Cronq.	Pink microsteris

HERBS (cont.)

Mirabilis linearis (Pursh) Heimerl	Narrow-leaved four-o'clock
Monarda fistulosa L. var. menthaefolia (Grah.) Fern.	Wild bergamot
Monolepis nuttalliana (Schultes) Greene	Patata
Misineon divaricatum (Pursh) Nutt.	Leafy musineon
Navarretia intertexta (Benth.) Hook. var. propinqua (Suksd.) Brand	Needle-leaf navarretia
Oenothera caespitosa Nutt. var. montana (Nutt.) Durand	Rock rose
Oenothera serrulata Nutt.	Shrubby evening-primrose
Oenothera strigosa mkze. & Bush	Common evening-primrose
Opuntia polyacantha Haw.	Starvation cactus
Orobanche fasciculata Nutt.	Clustered broomrape
Orthocarpus luteus Nutt.	Yellow owl-clover
Oxytropis besseyi (Rydb.) Blank. var. besseyi	Bessey's crazyweed
Oxytropis lagopus Nutt. var. lagopus	Rabbit-foot crazyweed
Oxytropis sericea Nutt. var. sericea	Silky crazyweed
Paronychia sessiliflora Nutt.	Whitlow herb
Penstemon albidus Nutt.	White-flowered penstemon
Penstemon eriantherus Pursh var. eriantherus	Fuzzytongue penstemon
Penstemon nitidus Doug. var nitidus	Shining penstemon
Petalostemon candidum Michx.	White prairie-clover
Petalostemon purpureum (Vent.) Rydb.	Purple prairie-clover
*Petasites sagittatus (Banks) Gray	Arrowleaf coltsfoot
Phacelia hastata Dougl. var.leucophylla (Torr.) Cronq.	Whiteleaf phacelia
Phacelia linearis (Pursh) Holz.	Threadleaf phacelia
Phlox hoodii Rich.	Hood's phlox
Plantago elongata Pursh	Slender plantain
Plantago major L. var. major	Common plantain
Plantago patagonica Jacq. var. patagonica	Indian wheat
Plantago patagonica Jacq. var. spinulosa (Dcne.) Gray	Indian wheat
Polygonum aviculare L.	Doorweed
Polygonum convolvulus L.	Ivy bindweed
Polygonum douglasii Greene var. douglasii	Douglas' knotweed
Potentilla norvegica L.	Norwegian cinquefoil
Psoralea argophylla Pursh	Silver-leaved scurf-pea
Psoralea esculenta Pursh	Indian bread-root
Psoralea tenuiflora Pursh	Slender-flowered scurf-pea
Ranunculus cymbalaria Pursh	Shore buttercup
Ranunculus glaberrimus Hook. var. ellipticus Greene	Sagebrush buttercup
Ratibida columnifera (Nutt.) Woot. & Standl.	Prairie cornflower
Rumex crispus L.	Curly dock

HERBS (cont.)

Rumex salicifolius Weinm. ssp. triangulivalvis Danser var. triangulivalvis	Willow dock
Salsola kali L.	Tumbleweed, Russian thistle
Senecio canus Hook.	Woolly groundsel
Sisymbrium altissimum L.	Jim Hill mustard
Sisymbrium loeselii L.	Loesel tumblemustard
Solanum triflorum Nutt.	Cut-leaved nightshade
Solidago missouriensis Nutt. var. missouriensis	Missouri goldenrod
Solidago mollis Bartl.	Velvety goldenrod
Sphaeralcea coccinea (Pursh) Rydb.	Red globe-mallow
Stephanomeria runcinata Nutt.	Runcinate-leaved skeletonweed
Taraxacum officinale Weber	Common dandelion
Thlaspi arvense L.	Field pennycress
Townsendia hookeri Beaman	Hooker's townsendia
Tradescantia occidentalis (Britt.) Smyth	Spiderwort
Tragopogon dubius Scop.	Yellow salsify
Verbena bracteata Lag. & Rodr.	Bracted vervain
Veronica peregrina L. var. xalapensis (H.B.K.) St. John & Warren	Purslane speedwell
Vicia americana Muhl. var. minor Hook.	American vetch
Viola nuttallii Pursh var. nuttallii	Yellow prairie violet
Woodsia oregana D.C. Eat.	Woodsia
Xanthium strumarium L. var. canadense (Mill.) T. & G.	Common cocklebur
Yucca glauca Nutt.	Soapwell
Zigadenus venenosus Wats. var. gramineus (Rydb.) Walsh	Death camas

PERENNIAL GRASSES AND SEDGES

Agropyron caninum (L.) Beauv. ssp. majus (Vasey) Hitchc. var. majus	Bearded wheatgrass
Agropyron caninum (L.) Beauv. ssp. majus (Vasey) Hitchc. var. unilaterale (Vasey) Hitchc.	Bearded wheatgrass
Agropyron cristatum (L.) Gaertn.	Crested wheatgrass
Agropyron smithii Rydb.	Bluestem wheatgrass
Agropyron spicatum (Pursh) Scribn. & Smith var. spicatum	Bluebunch wheatgrass
Andropogon scoparius Michx.	Little bluestem
Aristida fendleriana Steud.	Fendler three-awn
Aristida longiseta Steud.	Red three-awn
Bouteloua gracilis (H.B.K.) Lag.	Blue grama
Calamovilfa longifolia (Hook.) Scribn.	Prairie sandgrass
Carex filifolia Nutt.	Thread-leaved sedge
Carex praegracilis W. Boott	Clustered field sedge

PERENNIAL GRASSES AND SEDGES (cont.)

Distichlis stricta (Torr.) Rydb. var. stricta	Alkali saltgrass
Echinochloa crusgalli (L.) Beauv.	Large barnyard-grass
Eleocharis palustris (L.) R. & S.	Common spike-rush
Elymus ambiguus Vasey & Scribn. var. ambiguus	Colorado wildrye
Elymus canadensis L.	Canada wildrye
Elymus cinereus Scribn. & Merr. var. cinereus	Giant wildrye
Festuca idahoensis Elmer var. idahoensis	Blue Bunchgrass
Hordeum jubatum L.	Squirrel-tail barley
Koeleria cristata Pers.	Prairie junegrass
Muhlenbergia cuspidata (Torr.) Rydb.	Prairie rush-grass
Oryzopsis hymenoides (R. & S.) Ricker	Indiana ricegrass
Phleum pratense L.	Common timothy
Poa juncifolia Scribn.	Alkali bluegrass
Poa pratensis L.	Kentucky Bluegrass
Poa sandbergii Vasey	Sandberg's bluegrass
Poa scabrella (Thurb.) Benth.	Pine bluegrass
Schedonnardus paniculatus (Nutt.) Trel.	Tumblegrass
Scirpus americanus Pers.	American bulrush
Sitanion hystrix (Nutt.) Smith var. brevifolium (Smith) Hitchc.	Bottlebrush squirreltail
Sporobolus cryptandrus (Torr.) Gray	Sand dropseed
Stipa comata Trin. & Rupr. var. comata	Needle-and-thread
Stipa occidentalis Thurb. var. minor (Vasey) Hitchc.	Western needlegrass

ANNUAL GRASSES

Alopecurus carolinianus Walt.	Carolina foxtail
Bromus japonicus Thunb.	Japanese brome
Bromus tectorum L.	Cheat grass
Festuca octoflora Walt. var. hirtella (Piper) Hitchc.	Six-weeks fescue
Hordeum pusillum Nutt.	Little barley
Munroa squarrosa (Nutt.) Torr.	False buffalograss

* Identification tentative - plants not in flowering condition during sampling period.

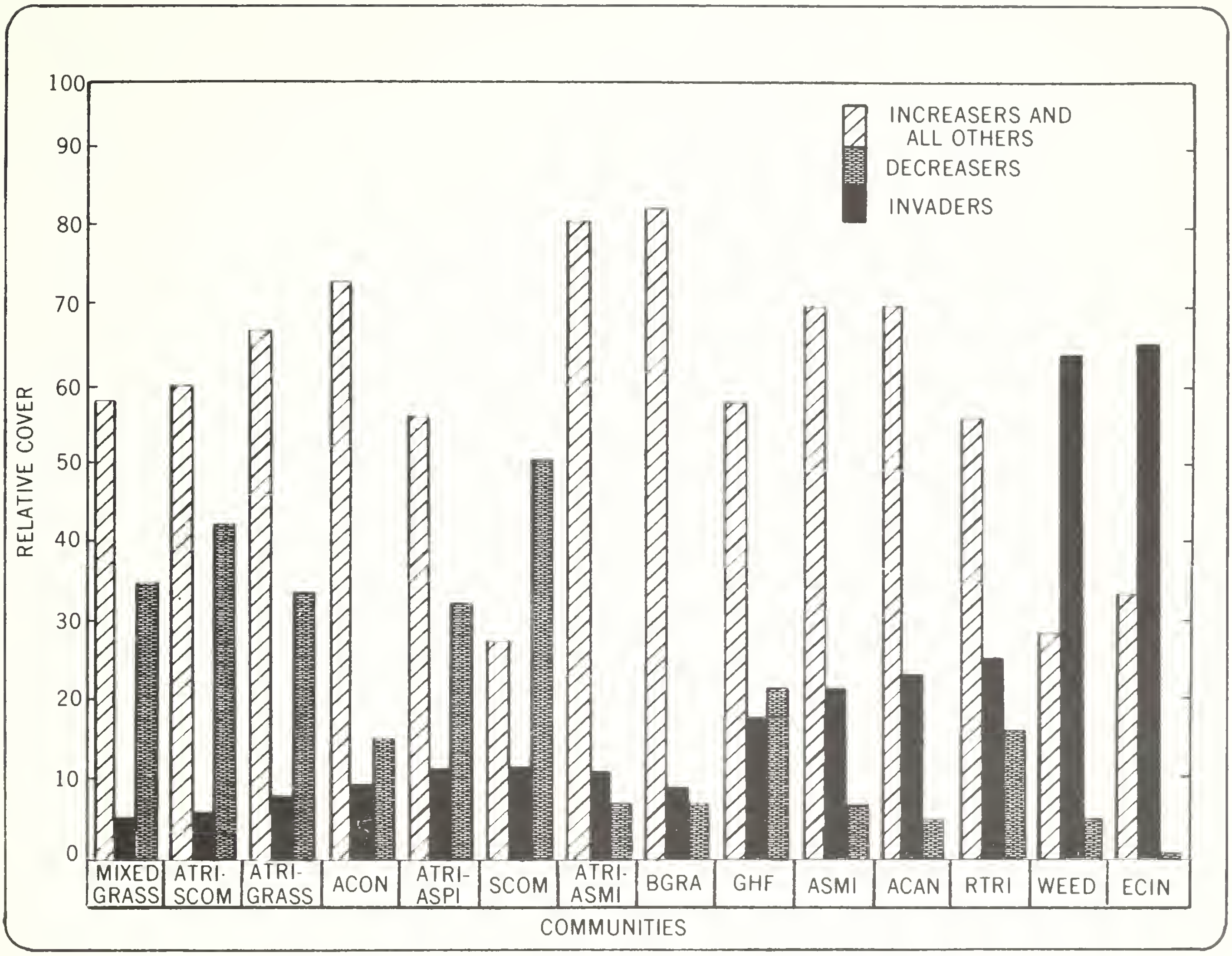
Appendix F-2. -- Annual Biomass Increment by Community and Functional Group

Community	Functional Group	$\bar{X}$ (g)	Range	N
Blue Grama				
BGRA (5)**	AG	0.38	0.1 - 0.8	5
"	PG	37.08	29.6 - 46.8	5
"	F	0.22	0.1 - 0.6	5
"	HS	1.98	0.0 - 9.9	1
"	O	0.02	0.0 - 0.1	1
WEED (43)**	AG	17.60	0.0 - 68.9	31
"	PG	75.50	0.0 - 287.6	43
"	L	13.02	0.0 - 256.1	26
"	F	22.95	0.0 - 293.6	40
"	HS	4.25	0.0 - 57.1	10
"	Co	0.02	0.0 - 0.9	1
"	C	0.20	0.0 - 9.1	1
"	CES	14.30	0.0 - 173.7	5
Grass/half-shrub/forb				
GHF (75)**	AG	0.03	0.0 - 0.7	13
"	PG	20.24	5.1 - 75.5	75
"	L	2.16	0.0 - 11.4	59
"	F	11.57	0.0 - 61.8	74
"	HS	11.51	0.0 - 66.6	66
"	O	1.53	0.0 - 104.8	6
"	C	1.72	0.0 - 15.9	25
"	Y	1.55	0.0 - 65.6	5
"	PP	0.31	0.0 - 2.3	1
MIXED GRASS (35)**	AG	6.01	0.0 - 34.6	34
"	PG	53.19	0.0 - 84.0	34
"	L	1.00	0.0 - 7.7	18
"	F	3.90	0.1 - 16.3	35
"	HS	2.61	0.0 - 27.7	12
"	C	0.61	0.0 - 15.6	3
"	O	4.45	0.0 - 44.1	5
Big sagebrush/mixed grass				
ATRI-GRASS (35)**	AG	2.84	0.0 - 22.6	30
"	PG	27.87	6.7 - 55.3	35
"	L	0.42	0.0 - 3.4	11
"	F	3.34	0.0 - 15.6	33
"	HS	2.19	0.0 - 12.7	18
"	O	12.64	0.0 - 165.9	9
Skunkbush				
RTRI (5)**	AG	5.18	1.4 - 7.7	5
"	PG	31.72	5.8 - 75.8	5
"	L	0.64	0.0 - 1.9	4
"	F	8.86	5.7 - 11.6	5
"	HS	6.06	0.2 - 27.8	5

Community	Funcitonal Group	$\bar{X}$ (g)	Range	N
Western wheatgrass				
ASMI (20)**	AG	6.39	0.1 - 32.7	20
"	PG	51.01	17.1 - 108.7	20
"	L	0.07	0.0 - 0.6	5
"	F	0.88	0.0 - 3.1	17
"	O	0.58	0.0 - 41.1	3
Big sagebrush/blue bunch wheatgrass				
ATRI-ASPI (30)**	AG	1.18	0.0 - 20.6	24
"	PG	31.72	8.1 - 100.8	30
"	L	1.16	0.0 - 12.5	20
"	F	6.48	0.0 - 39.6	26
"	HS	2.23	0.0 - 12.6	16
"	O	6.23	0.0 - 141.3	3
Big sagebrush/western wheatgrass				
ATRI-ASMI (10)**	AG	1.18	0.0 - 4.1	8
"	PG	24.30	8.3 - 47.4	10
"	F	5.89	0.1 - 30.6	10
"	HS	0.89	0.4 - 3.0	5
"	O	9.18	0.0 - 72.6	4
Needle-and-thread				
SCOM (5)**	AG	15.90	3.9 - 36.8	5
"	PG	37.40	26.8 - 51.6	5
"	L	0.10	0.0 - 0.5	1
"	F	0.60	0.2 - 0.9	5
"	O	35.22	0.0 - 138.9	2
"	C	0.42	0.0 - 2.1	1
Big sagebrush/needle-and-thread				
ATRI-SCOM (15)**	AG	1.39	0.0 - 10.6	12
"	PG	21.85	8.1 - 32.1	15
"	L	0.85	0.0 - 3.5	9
"	F	6.71	0.1 - 36.1	15
"	H	7.45	0.0 - 32.5	10
"	C	0.08	0.0 - 0.9	2
"	O	4.37	0.0 - 63.4	2
"	Y	0.28	0.0 - 2.7	2
Silver sagebrush				
ACAN (5)**	AG	3.06	1.0 - 5.3	5
"	PG	105.34	45.7 - 191.8	5
"	L	17.50	0.0 - 69.0	3
"	F	0.38	0.0 - 1.1	3
"	HS	0.06	0.0 - 0.3	1

KEY to Functional Groups

O	=	*Opuntia polyacantha*
Co	=	*Coryphantha missouriensis*
C	=	*Carex filifolia*
CES	=	*Carex* spp. and *Eleocharis palustris* and *Scirpus americanus*
AG	=	Annual grasses
PG	=	Perennial grasses
L	=	Legumes
F	=	Forbs
HS	=	Half-shrubs
Y	=	*Yucca glauca*
PP	=	*Pinus ponderosa* seedling
*	=	sample of $3m^2$
N	=	Number of occurrences
S.D.	=	Standard Deviation
$\bar{X}(g)$	=	Mean weight/m^2 in grams
**	=	Total number of $1m^2$ samples



RANGE CONDITION BY COMMUNITY

Appendix G-1

MAMMAL SPECIES LIST[1]

Insectivora		
*	Masked shrew	Sorex cinereus
*	Merriam's shrew	Sorex merriami
*	Vagrant shrew	Sorex vagrans
Chiroptera		
*	Keen's myotis	Myotis keenii
	Little brown myotis	Myotis lucifugus
	Long-eared myotis	Myotis evotis
	Marked or Least myotis	Myotis leibii
	Long-legged myotis	Myotis volans
	Small-footed myotis	Myotis subulatus
*	Silver-haired bat	Lasionycteris noctivagans
*	Big brown bat	Eptesicus fuscus
*	Hoary bat	Lasiurus cinereus
*	Spotted bat	Euderma maculatum
	Western big-eared bat	Plecotus townsendii
Carnivora		
	Long-tailed weasel	Mustela frenata
*	Badger	Taxidea taxus
	Striped skunk	Mephitis mephitis
	Coyote	Canis latrans
	Red fox	Vulpes vulpes
	Bobcat	Lynx rufus
Rodentia		
	Yellow-bellied marmot	Marmota flaviventris
	Black-tailed prairie dog	Cynomys ludovicianus
	Thirteen-lined ground aquirrel	Spermophilus tridecemlineatus
	Least chipmunk	Eutamias minimus
*	Northern pocket gopher	Thomomys talpoides
	Olive-backed pocket mouse	Perognathus fasciatus
	Ord's Kangaroo Rat	Dipodomys ordii
	Western harvest mouse	Reithrodontomys megalotis
*	White-footed mouse	Peromyscus leucopus
	Deer mouse	Peromyscus maniculatus
	Northern grasshopper mouse	Onychomys leucogaster
	Bushy-tailed woodrat	Neotoma cinerea
	Meadow vole	Microtus pennsylvanicus
*	Prairie vole	Microtus ochrogaster
*	Longtail vole	Microtus longicaudus
*	Sagebrush vole	Lagurus curtatus
	Muskrat	Ondatra zibethicus
	Porcupine	Erethizon dorsatum
Lagomorpha		
	White-tailed jack rabbit	Lepus townsendii
	Desert cottontail	Sylvilagus audubonii

1 Taken from VTN Wildlife Report on Spring Creek Project

Appendix G-1

MAMMAL SPECIES LIST (cont.)

Artiodactyla	
White-tailed deer	Odocoileus virginianus
Mule deer	Odocoileus hemionus
Pronghorn	Antilocapra americana

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* Designates species whose ranges overlap the study area but were not observed during the study.

Appendix G-1

AVIAN SPECIES LIST

Western Grebe	Aechmophorus occidentalis
White Pelican	Pelecanus erythrorhynchos
Double-crested Cormorant	Phalacrocorax auritus
Great Blue Heron	Ardea herodias
Canada Goose	Branta canadensis
White-fronted Goose	Anser albifrons
Mallard	Anas platyrhynchos
Gadwall	Ansa strepera
Pintail	Anas acuta
Green-winged Teal	Anas carolinensis
Blue-winged Teal	Anas discors
American Widgeon	Mareca americana
Northern Shoveler	Spatula clypeata
Redhead	Aythya americana
Ring-necked Duck	Aythya collaris
Lesser Scaup	Aythya affinis
Common Merganser	Mergus merganser
Turkey vulture	Cathartes aura
Goshawk	Accipiter gentilis
Sharp-shinned Hawk	Accipiter striatus
Red-tailed Hawk	Buteo jamaicensis
Red-tailed Hawk (Harlan's)	Buteo jamaicensis
Swainson's Hawk	Buteo swainsonii
Rough-legged Hawk	Buteo lagopus
Ferruginous Hawk	Buteo regalis
Golden Eagle	Aquila chrysaetos
Bald Eagle	Haliaeetus leucocephalus
Marsh Hawk	Circus cyaneus
Osprey	Pandion haliaetus
Prairie Falcon	Falco mexicanus
Peregrine Falcon	Falco peregrinus
Merlin	Falco columbarius
American Kestrel	Falco sparverius
Sharp-tailed Grouse	Pedioecetes phasianellus
Sage Grouse	Centrocercus urophasianus
Ring-necked Pheasant	Phasianus colchicus
Gray Partridge	Perdix perdix
American Coot	Fulica americana
Killdeer	Charadrius vociferus
Common Snipe	Capella gallinago
Long-billed Curlew	Numenius americanus
Upland Sandpiper	Bartramia longicauda
Spotted Sandpiper	Actitis macularia
Solitary Sandpiper	Tringa solitaria

AVIAN SPECIES LIST (cont.)

Willet	Catoptrophorus semipalmatus
Long-billed Dowitcher	Limnodromus scolopaceus
Wilson's Phalarope	Steganopus tricolor
Ring-billed gull	Larus delawarensis
Mourning Dove	Zenaidura macroura
Rock Dove	Columba livia
Great-horned Owl	Bubo virginianus
Short-eared Owl	Asio flammeus
Long-eared Owl	Asio otus
Poor-will	Phalaenoptilus nuttallii
Common Nighthawk	Chordeiles minor
Belted Kingfisher	Megaceryle alcyon
Common Flicker	Colaptes auratus
Red-headed Woodpecker	Melanerpes erthrocephalus
Lewis's Woodpecker	Asyndesmus lewis
Hairy Woodpecker	Dendrocopos villosus
Downy Woodpecker	Dendrocopos pubescens
Eastern Kingbird	Tyrannus tyrannus
Western Kingbird	Tyrannus verticalis
Say's Phoebe	Sayornis saya
Western Wood Pewee	Contopus sordidulus
Horned Lark	Eremophila alpestris
Violet-green Swallow	Tachycineta thalassina
Tree Swallow	Iridoprocne bicolor
Rough-winged Swallow	Stelgidopteryx ruficollis
Barn Swallow	Hirundo rustica
Cliff Swallow	Petrochelidon pyrrhonota
Black-billed Magpie	Pica pica
Common Raven	Corvus corax
Common Crow	Corvus brachyrhynchos
Pinyon Jay	Gymnorhinus cyanocephalus
Black-capped Chickadee	Parus atricapillus
White-breasted Nuthatch	Sitta carolinensis
Red-breasted Nuthatch	Sitta canadensis
Brown Creeper	Certhia familiaris
House Wren	Troglodytes aedon
Rock Wren	Salpinctes obsoletus
Sage Thrasher	Oreoscoptes montanus
American Robin	Turdus migratorius
Eastern Bluebird	Sialia sialis
Mountain Bluebird	Sialia currucoides
Townsend's Solitaire	Myadestes townsendi
Bohemian Waxwing	Bombycilla garrulus
Cedar Waxwing	Bombycilla cedrorum

AVIAN SPECIES LIST (cont.)

Starling	Sturnus vulgaris
Northern Shrike	Lanius excubitor
Loggerhead Shrike	Lanius ludovicianus
Yellow Warbler	Dendroica petechia
Yellow-rumped Warbler (Myrtle)	Dendroica coronata
Common Yellowthroat	Geothlypis trichas
Wilson's Warbler	Wilsonia pusilla
Western Meadowlark	Sturnella neglecta
Red-winged Blackbird	Angelaius phoeniceus
Northern Oriole (Bullcok's)	Icterus galbula
Brewer's Blackbird	Euphagus cyanocephalus
Common Grackle	Quiscalus quiscula
Black-headed Grosbeak	Pheucticus melanocephalus
Gray-crowned Rosy Finch	Leucosticte tephrocotis
Common Redpoll	Acanthis flammea
Pine Siskin	Spinus pinus
American Goldfinch	Spinus tristis
Rufous-sided Towhee	Pipilo erythrophthalmus
Lark Bunting	Calamospiza melanocorys
Savannah Sparrow	Passerculus sandwichensis
Grasshopper Sparrow	Ammodramus savannarum
Baird's Sparrow	Ammodramus bairdii
Lark Sparrow	Chondestes grammacus
Vesper Sparrow	Pooecetes gramineus
Dark-eyed Junco	Junco hyemalis
Tree Sparrow	Spizella arborea
Chipping Sparrow	Spizella passerina
Clay-colored Sparrow	Spizella pallida
Brewer's Sparrow	Spizella breweri
White-crowned Sparrow	Zonotrichia leucophrys
Fox Sparrow	Passerella iliaca
Song Sparrow	Melospiza melodia
Snow Bunting	Plectrophenax nivalis

Appendix G-1

AMPHIBIAN AND REPTILE SPECIES

Urodela		
*	Blotched Tiger Salamander	Ambystoma tigrinum
Anura		
	Boreal Chorus Frog	Pseudacris triseriata maculata
	Leopard Frog	Rana pipiens
	Rocky Mountain Toad	Bufo woodhousei woodhousei
*	Plains Spadefoot	Scaphiopus bombifrons
	Great Plains Toad	Bufo cognatus
Testudina		
*	Snapping Turtle	Chelydra serpentina
	Painted Turtle	Chrysemys picta
*	Spiny Softshell	Trionyx spiniferus
Squamata		
	Northern Sagebrush Lizard	Scelporus graciosus graciosus
	Eastern Short-horned Lizard	Phrynosoma douglassi brevirostre
	Plains Hognose Snake	Heterodon nasicus nasicus
	Eastern Yellow-bellied Racer	Coluber constrictor flaviventris
	Bullsnake	Pituophis melanoleucas sayi
	Prairie Rattlesnake	Crotalus viridis viridis
	Red-sided Garter Snake	Thamnophis sirtalis parietalis
	Wandering Garter Snake	Thamnophis elegans vagrans
*	Western Plains Garter Snake	Thamnophis radix haydeni
*	Pale Milk Snake	Lampropeltis triangulum multistrata

* Designates species whose ranges overlap the study area but were not observed during the study.

United States Department of the Interior
FISH AND WILDLIFE SERVICE
P.O. Box 916
Sheridan, Wyoming 82801
307-672-5826

Appendix G-2

March 6, 1978

Mr. Douglas H. Hileman
Chief Mining Supervisor
U.S. Geological Survey
P.O. Box 2550
Billings, Montana 59101

Dear Mr. Hileman:

It has come to my attention from recent communications with NERCO personnel and Burt Rounds, Area Manager for the U.S. Fish and Wildlife Service, that there has been a considerable misunderstanding over the locations and status of golden eagle nests on a proposed NERCO mine in Big Horn County, Montana. We have been conducting intensive surveys of breeding birds of prey for 2 years in a region which includes the Spring Creek lease. I can perhaps clarify the eagle nest situation.

Only one eagle nest site exists on the immediate mining area (Section 19, T8S, R40E). This nest was active in 1977 but was destroyed by wind. Another golden eagle nest is located some 2 miles to the west of the proposed mine in Section 20, T8S, R39E. Two other nests were at one time or another incorrectly labeled as inactive golden eagle eyries and are located in Section 25, T8S, R39E and Section 32, T8S, R40E. Both of these nests are typically buteonine in construction and have not been occupied during the course of our investigation.

From a biological standpoint and aside from any legal constraints governing nest disturbances, it would be very difficult to assess the importance of the three nests located on the mine site. The destruction of the eagle

nest on Spring Creek will not necessarily affect the viability of the pair which is still present by all indications. Nests of eagles are frequently destroyed only to be rebuilt in successive years. At this time I would personally attach little significance to the existence of the two buteo nests even though it is possible that the eagles may attempt to utilize one of these structures in the future.

I hope that this information will be helpful to you in considering proposed mine plans on Spring Creek.

Sincerely,

Mike Lockhart

J. Michael Lockhart
Wildlife Research Biologist

cc:
Mike Eidlin, NERCO
Ray Hoem, FWS
Burt Rounds, FWS
Len Ruggiero, VTN
Dick Juntunen, Montana State Lands
Gerry Gill, BLM

Appendix I-1

Montana Taxes.--State and local tax revenues for Montana in 1974 and 1976 fiscal years were $427.56 million and $536.399 million, respectively (Table A). Of the 1974 total, 54.3 percent was generated by the property tax, 18.4 percent by individual income tax, 8.3 percent by motor fuel taxes, 3.7 percent by corporate license and 2.7 percent by natural resource taxes. In 1976, 52.3 percent of the revenues was attributed to property tax, 18.2 percent to individual income tax, 7.7 percent to motor fuel tax, 4.3 percent to corporate license and 6.3 percent to natural resource tax. The trend appears to be a gradual replacement of property tax by severance tax and a greater reliance on the latter in the future.

The tax system for Montana for state and county jurisdiction by type of tax and maximum mill limit is presented in Table II-B-9. Tables II-B-10 and II-B-11 present a detailed account of tax levies, revenues, rates and valuations of Big Horn County from 1960 to 1974. In general, the data indicate increased assessed valuation, increased taxable valuations, increased revenues for state, county, schools, cemeteries, and municipalities with decreased rates and decreased levies.

Table A.--State and Local Tax Revenues, State of Montana, 1974 and 1976 fiscal years

	1974		1976	
	($000)	Percent	($000)	Percent
Total Taxes	427,560	100.0	536,399	100.0
Property	232,310	54.3	280,419	52.3
Individual Income	78,758	18.4	97,520	18.2
Motor Fuel, Total	35,451	8.3	41,246	7.7
Gasoline Licenses and Tax	28,406		32,939	
Diesel Fuel	6,635		7,915	
Aviation Fuel	363		356	
Liquefied Petroleum License and Tax	47		36	
Corporate License	15,638	3.7	23,020	4.3
Natural Resource, Total	11,530	2.7	33,923	6.3
Oil Producers License and Tax	4,256		6,564	
Coal License and Tax	3,315		22,924	
Metalliferous Mines	2,240		1,845	
Resource Indemnity Trust	1,138		1,981	
Natural Gas Distributors	407		446	
Cement and Gypsum	143		151	
Micaceous Mines	11		12	
Motor Vehicle a/	10,891	2.6	12,064	2.2
Cigarette and Tobacco	10,459	2.5	11,155	2.1
Alcoholic Beverages, Total b/	9,462	2.2	10,297	1.9
Wines and Spirits	5,730		5,900	
Beer License and Tax	2,214		2,250	
County License	1,202		1,778	
Liquor License	316		369	
Insurance	7,367	1.7	9,483	1.8
Inheritance	5,563	1.3	5,902	1.1
Motor Vehicle Registration	5,331 c/	1.3	5,748	1.1
Utility and Other Service License	2,383	0.6	2,705	0.5
Miscellaneous Business and Consumer License	1,283	0.3	1,663	0.3
Drivers and Chauffeur Licenses	1,154	0.3	1,254	0.2

a/ Includes GVW, motor carrier fees, and miscellaneous.
b/ Does not include profits from liquor stores of $7,274,480.
c/ Figure is for 1975.

Source: Biennial Reports of the State Department of Revenue; information booklets of the Montana Department of Highways; Commerce Clearing House, State Tax Handbooks; letters and telephone conversations with departments of State government.

Table B.--Summary of Montana tax laws for state and county jurisdiction for 1974

	Mill Limit
State Property Taxes	
General Fund	2.0
University Fund	6.0
Statewide Deficiency Levy for Public Schools	As Needed
Statewide Public School Supplemental Permissive Levy	9.0
Special Livestock	9.0
Property Tax Administration (Repealed)	
Total	21.0
County Property Taxes	
General Fund	25.0-27.0
Poor Fund	13.5
Bond Sinking and Interest	As Necessary
Road	12.0
Emergency Levies	2.0
Employee Retirement	
Bridge Tax	3.0-5.0
Special Bridge and Road Tax	10.0-5.0
Airport Tax	2.0
Airport Authority	No Limit
Public Ferry Tax	2.0
County Fair Tax	1.5
Library Tax	3.0
Rodent Control Tax	2.0
Insect Pest Tax	1.0
Weed Control	2.0
Extension Work in Agriculture and Home Economics	No Limit
Fire Districts	As Necessary
Soil Conservation Districts	1.5
Conserving Districts	2.0-5.0
Cemetery	2.0
Local Boards of Health County	2.0
Museum Fund Tax	0.5
Mosquito Control District	5.0
Planning and Zoning	2.0-6.0
Hospital Districts	3.0
County Park Commission	As Needed
Civic Center Tax	2.0
Special Improvement Districts	
Ambulance Services Levy	1.0
Recreational Program - Elderly	1.0

Montana Taxpayers' Association; Tax Laws of Montana with Amendments of 1974 Legislation, Helena, Montana, 1974.

Table C.--Tax levies - Big Horn County, Montana
1969-1974

	1969		1970		1971		1972		1973		1974	
	Detail	Total	Detail	Total	Detail	Total	Detail	Total	Detail	Total	Detail	Total
State Levies		8.20		8.30		6.10		6.00		21.00		6.00
General Fund	2.00		2.00		0		0		0		0	
All Other	6.20		6.30		6.10		6.00		21.00		6.00	
Livestock Levies												
Sheep	12.00		12.00		12.00		11.00		11.50		11.50	
All Other Livestock	10.50		10.50		10.00		10.00		10.50		10.50	
County Levies		21.26		24.67		34.04		33.75		31.36		18.80
General Fund	13.30		14.50		17.26		19.47		18.75		10.06	
Debt Service	0		0		6.00		0.89		0.45		0.71	
All Other Levies	7.96		10.17		10.78		13.39		12.16		8.03	
Special County Levies		55.36		56.82		59.40		60.85		66.53		57.80
Planning	0		0.33		0.14		0.26		1.26		1.61	
Roads	6.38		6.26		10.11		10.53		10.86		7.92	
Countywide Schools	48.98		49.44		48.76		49.67		53.64		47.91	
All Other	0		0.79		0.39		0.39		0.77		0.36	
School District Levies												
District #1	9.99		4.27		11.57		6.45		9.06		2.68	
2	16.82		13.95		16.59		23.75		19.12		15.43	
16	29.83		20.98		33.87		27.13		26.74		26.17	
17H	23.23		31.29		59.39		49.26		35.81		36.30	
17K	10.22		13.62		25.90		26.72		13.23		32.52	
27	16.64		17.24		27.36		32.64		29.26		20.92	
29	22.68		37.55		32.93		42.60		33.93		26.67	
City Levies												
Hardin		44.81		51.39		49.66		51.12		57.25		62.50
General Fund	5.92		9.68		7.60		8.33		48.00		55.50	
Debt Service	3.53		3.83		2.40		2.27		2.25		2.00	

Table C.--(Cont.)

	1969		1970		1971		1972		1973		1974	
	Detail	Total	Detail	Total	Detail	Total	Detail	Total	Detail	Total	Detail	Total
All Other	35.36		36.88		38.66		40.02		7.00		5.00	
City-County Planning	0		1.00		1.00		0.50		0		0	
Lodge Grass		60.00		60.00		60.00		60.00		60.00		65.00
General Fund	24.00		24.00		24.00		24.00		24.00		65.00	
Debt Service	0		0		0		0		0		0	
All Other	36.00		36.00		36.00		36.00		36.00		0	
Cemeteries												
District 1 (17H and 16)	0.54		1.62		0.89		Nil		1.15		1.11	
District 2 (27 and 29)	1.02		0.62		0.90		0.96		0.81		1.03	

Table D.--Tax revenues, rates, and valuations, Big Horn County, Montana 1969, 1971, 1973, and 1974

	1969		1971		1973		1974	
	Rates	Revenues	Rates	Revenues	Rates	Revenues	Rates	Revenues
District 1								
(Decker Area)								
State	8.20	4,909	6.10	3,926	21.00	23,707	6.00	71,963
County	76.62	45,873	93.44	60,133	97.89	110,509	76.60	918,722
School	9.99	5,981	11.57	7,446	9.06	10,228	2.68	32,143
Total	94.81	56,763	111.11	71,505	127.95	144,444	85.28	1,022,828
Assessed Valuation	2,074,563		2,291,124		6,054,041		16,624,243	
Taxable Valuation	598,708		643,547		1,128,910		11,993,754	
District 2								
(Pryor Area)								
State	8.20	5,803	6.10	4,534	21.00	17,517	6.00	5,468
County	76.62	54,219	93.44	69,457	97.89	81,654	76.60	69,805
School	16.82	11,902	16.59	12,332	19.12	15,949	15.43	14,061
Total	101.64	71,924	116.13	86,323	138.01	115,120	98.03	89,334
Assessed Valuation	2,321,594		2,382,339		2,718,166		2,954,788	
Taxable Valuation	707,629		743,336		834,137		911,292	
District 16								
(North Hardin)								
State	8.20	6,146	6.10	4,842	21.00	18,337	6.00	5,774
County	76.62	57,423	93.44	74,164	97.89	85,478	76.60	73,712
School	29.83	22,356	33.87	26,883	26.74	23,350	26.17	25,183
Cemetery	0.54	405	0.89	706	1.15	1,004	1.11	1,068
Total	115.19	86,330	134.30	106,595	146.78	128,169	109.88	105,737

Table D.--(Cont.)

	1969		1971		1973		1974	
	Rates	Revenues	Rates	Revenues	Rates	Revenues	Rates	Revenues
Assessed Valuation	2,629,750		2,794,688		3,013,617		3,322,370	
Taxable Valuation	749,456		793,703		873,205		962,295	
District 17H (Hardin Area)								
State	8.20	67,532	6.10	51,902	21.00	187,502	6.00	66,122
County	76.62	631,019	93.44	795,033	97.89	874,027	76.60	883,463
School	23.23	191,315	59.39	505,319	35.81	319,736	36.30	418,191
Cemetery	0.54	4,447	0.89	7,573	1.15	10,267	1.11	12,788
Total	108.59	894,313	159.82	1,359,827	155.85	1,391,532	120.01	1,379,564
Assessed Valuation	30,630,525		31,262,501		32,793,462		40,633,612	
Taxable Valuation	8,235,699		8,508,487		8,928,671		11,520,411	
Hardin, City of	44.81	102,611	49.66	122,344	57.25	149,882	62.50	185,002
Assessed Valuation	8,742,175		8,515,506		10,387,855		11,221,575	
Taxable Valuation	2,289,023		2,463,635		2,618,028		2,960,026	

Wyoming Taxes.--Wyoming tax sources were \$273.167 million in fiscal year 1974-75, compared with \$333.750 million in 1975-76 (Table E). Of the 1974-75 total, 48 percent was accounted for by property tax, 22 percent from sales tax, 5 percent from user tax, 7 percent from gasoline tax, and 7 percent from mineral severance tax. For the 1975-76 total, 47 percent was accounted for by property tax, 22 percent from sales taxes, 4 percent from gasoline tax, and 12 percent from mineral severance tax.

Each State within the impacted area has special provisions in terms of levies and mill rates as well as special provisions for inter-governmental flows to local units of government of the county, town, and school district levels.

Table E.--Tax and other general revenue from own sources, State and Local government in Wyoming 1974-5 and 1975-6 Fiscal Years a/

Source of Revenue	1974-5 ($000)	1975-6 ($000)
Total General Revenue from Own Sources	319,092	b/
Taxes from Own Sources, Total	273,167	333,750
Property	131,083	156,681
Sales	60,203	73,900
Use	12,863	14,037
Gasoline	20,217	22,421
Compensatory and Other Motor Related	13,631	15,263
State Motor Vehicle Registration	3,672	4,596
County Motor Vehicle Registration	6,912	b/
Mineral Severance	18,175	40,335
Coal Excise	c/	282
Cigarette	4,248	4,526
Inheritance	1,575	1,426
Insurance Companies	3,058	283
Alcoholic Beverages	1,161	b/
Other Revenues from Own Sources	45,925	b/
Liquor Commission Profits	1,664	
Mineral Royalties	29,385	
State Lands Income	8,389	
Employment Insurance	6,487	

a/ Data are compiled from several sources which may not be consistent in method of reporting. Amounts levied and collected differ due to delinquencies and refunds. Costs of admininstration are deducted in some reports but not others. Property taxes are levied in one year but collected in another.

b/ Not available.
c/ Initiated in 1975.

Table F.--Taxes collected, mill levy and assessed valuation for 1964, 1967 and 1970 to 1974 for City of Sheridan, Wyoming

Year	Assessed Valuation	Mill Levy[1]	Taxes Collected
1974	$17,668,165	12.96	$228,978
1973	16,978,063	12.81	217,998
1972	16,435,373	13.73	225,657
1971	15,676,912	14.08	220,731
1970	15,807,480	14.42	227,943
1967	15,744,732	14.58	229,559
1964	15,329,079	11.71	179,502

[1]The total tax burden to property within the corporate limits of Sheridan is as follows:

	Mills
City Taxes	12.96
School Taxes*	47.66
County Taxes	10.20
Special Districts	1.32

*Including State Foundation Fund

TABLE G

1977 Property Valuation for

Wyoming School Districts

	Valuation per AUM
Richest District	$175,560
Statewide Average	30,854
District #1	14,034
District #2	12,865
Poorest District	10,216

TABLE H

Source of School Revenue, 1976-77
Sheridan School Districts
($000,000)

	Total*	Local	%	County	%	State	%	Federal	%
Dist. 1	1.2	.29	24	.16	13	.74	61	.02	2
Dist. 2	4.7	1.30	26	.67	14	2.80	58	.09	2

*Excluding Cash on Hand

Appendix I-2

The following additional information is made available from the Coal Town II Model as described in Chapter II (Economics). It was assumed that the following tonnage increases would be mined in Big Horn and Sheridan Counties (from existing mines).

	Big Horn Co.	Sheridan Co.	(Total MTY)
1978	16.5	13.9	30.4 MTY
1979	20.0	25.0	45.0 MTY
1980	24.8	25.0	49.8 MTY
1981	30.0	25.0	55.0 MTY
1982	30.0	25.0	55.0 MTY
1983	33.0	25.0	55.0 MTY
1984	33.0	25.0	58.0 MTY
1985	33.5	25.0	58.5 MTY
1986	33.5	25.0	58.5 MTY
1987	33.5	25.0	58.5 MTY
1988	33.5	25.0	58.5 MTY
1989	33.5	25.0	58.5 MTY
1990	33.5	25.0	58.5 MTY

It is further assumed in the Coal Town II Model that prices change and affect the future. The following price index is utilized for both counties (Taken from the Chase Forecasts).

Year	Price Index 1970=100.
1978	1.66
1979	1.76
1980	1.86
1981	1.98
1982	2.11
1983	2.24
1984	2.37
1985	2.50
1986	2.64
1987	2.79
1988	2.94
1989	3.10
1990	3.27

Estimates are also made available for ancillary wages (1978-90) per mine worker. Obvious increases are evident through 1990.

Ancillary Wages/Mine Worker

Year	Dollars
1978	$5,989
1979	4,912
1980	6,329
1981	6,592
1982	5,062
1983	5,957
1984	6,017
1985	6,003
1986	6,258
1987	6,072
1988	6,089
1989	6,079
1990	7,177

Employment population ratios estimates are also made available below showing a rough participation rate of employment to ever changing population levels.

Employment/Population Ratios
1978-1990

Year	Big Horn Co.	Sheridan Co.
1978	.425	.461
1979	.429	.460
1980	.435	.463
1981	.439	.463
1982	.443	.463
1983	.445	.463
1984	.446	.462
1985	.448	.461
1986	.448	.459
1987	.448	.457
1988	.447	.455
1989	.447	.453
1990	.4303	.455

In 1989 and 1990, estimates of this ratio decline indicating a

participation ratio similar to 1978-79. Throughout the period of 1978 to 1990 Sheridan County is estimated to have a higher participation ratio. This may be in part to it being the working center as well as having the majority of the new additional activity relative to Big Horn County.

Estimated fiscal conditions are made available by the county for the years 1978 through 1990.

State Revenues Generated by the County
1978-1990

Year	Big Horn Co.	Sheridan Co.
1978	33,157,696.	2,906,476.
1979	41,856,704.	4,511,409.
1980	56,173,488.	4,829,540.
1981	70,975,984.	5,039,452.
1982	73,475,824.	5,353,567.
1983	85,352,352.	5,688,359.
1984	91,235,440.	6,035,880.
1985	96,130,416.	6,395,248.
1986	101,263,808.	6,882,805.
1987	106,292,800.	7,158,706.
1988	111,965,168.	7,617,289.
1989	117,923,856.	8,064,088.
1990	125,754,704.	12,463,632.

Estimate Big Horn County Fiscal Conditions
1978-1990

Year	Co. Revenue	Co. Expeditures	Surplus
1978	1,706,468.	1,121,543.	584,925.
1979	2,158,016.	975,465.	1,182,550.
1980	2,046,190.	1,340,414.	705,776.
1981	2,510,643.	1,511,434.	999,209.
1982	2,641,577.	1,249,194.	1,392,383.
1983	3,005,023.	1,574,767.	1,430,256.
1984	3,195,208.	1,699,697.	1,495,511.
1985	3,354,283.	1,811,188.	1,543,095.
1986	3,523,207.	2,021,757.	1,501,450.
1987	3,700,279.	2,097,158.	1,603,121.
1988	3,887,343.	2,248,724.	1,638,619.
1989	4,085,177.	2,400,457.	1,684,720.
1990	4,304,844.	3,105,498.	1,199,346.

Estimated Sheridan County Fiscal Conditions
1978-1990

Year	Revenues	Expenditures	Surplus
1978	1,145,133.	6,123,491.	-4,978,358.
1979	1,330,428.	6,410,988.	-5,080,560.
1980	1,413,888.	9,955,533.	-8,541,645.
1981	1,467,511.	9,297,239.	-7,829,728.
1982	1,541,283.	9,841,889.	-8,300,606.
1983	1,618,720.	10,648,825.	-9,030,105.
1984	1,698,149.	11,450,692.	-9,752,543.
1985	1,780,854.	12,200,022.	-10,419,168.
1986	1,880,021.	13,871,853.	-11,991,832.
1987	2,979,548.	14,313,449.	-11,333,901.
1988	2,067,949.	15,190,551.	-13,133,602.
1989	2,173,481.	16,164,649.	-13,991,168.
1990	2,754,748.	21,860,224.	-19,105,472.

Estimated School District Fiscal Conditions
Big Horn County
1978-1990

Year	Revenues	Expenditures	Surplus
1978	4,642,111.	3,542,491.	1,099,620.
1979	5,630,812.	3,080,178.	2,550,634.
1980	7,012,471.	4,245,721.	2,766,750.
1981	8,560,821.	4,832,346.	3,728,475.
1982	9,000,028.	4,015,982.	4,984,046.
1983	10,210,303.	5,091,139.	5,119,164.
1984	10,846,474.	5,537,400.	5,319,074.
1985	11,379,714.	5,925,399.	5,454,315.
1986	11,946,826.	6,661,531.	5,285,395.
1987	12,541,082.	6,959,209.	5,581,873.
1988	13,168,631.	7,515,457.	5,653,174.
1989	13,831,985.	8,079,444.	5,752,541.
1990	14,582,490.	10,666,614.	3,915,876.

Estimated School District Fiscal Conditions
Sheridan County
1978-1990

Year	Revenues	Expenditures	Surplus
1978	8,083,348.	7,963,647.	119,701.
1979	8,600,711.	8,330,919.	269,792.
1980	8,861,068.	12,945,029.	-4,083,961.
1981	9,147,812.	12,097,214.	-2,949,402.
1982	9,453,085.	12,814,513.	-3,361,428.
1983	9,762,473.	13,874,629.	-4,112,156.
1984	10,082,763.	14,929,816.	-4,847,053.
1985	10,419,233.	15,917,996.	-5,498,763.
1986	10,797,262.	18,114,960.	-7,317,698.
1987	11,120,114.	18,708,048.	-7,587,934.
1988	11,609,832.	19,871,568.	-8,261,736.
1989	12,043,816.	21,163,504.	-9,119,688.
1990	13,807,129.	28,704,912.	-14,897,783.

Estimated Growth of Students Per County
1978-1990

Year	Big Horn Co.	Sheridan Co.
1978	2,785.	6,060.
1979	2,783.	5,975.
1980	2,808.	6,041.
1981	2,884.	6,114.
1982	2,930.	6,188.
1983	2,977.	6,263.
1984	3,028.	6,341.
1985	3,080.	6,420.
1986	3,144.	6,520.
1987	3,209.	6,622.
1988	3,275.	6,724.
1989	3,342.	6,825.
1990	3,542.	7,191.

Tons Mined

The following tonnage is assumed to be mined by the given respective years by county as given in Table A below. (Including the Spring Creek Mine).

TABLE A
Tons of Coal Mined by Year
Big Horn and Sheridan County
(1978-1990)

Year	Big Horn Co.	Sheridan Co.
1978	16,500,000.	1,399,999.
1979	20,000,000.	2,500,000.
1980	27,899,984.	2,500,000.
1981	37,000,000.	2,500,000.
1982	40,000,000.	2,500,000.
1983	43,000,000.	2,500,000.
1984	43,500,000.	2,500,000.
1985	43,500,000.	2,500,000.
1986	43,500,000.	2,500,000.
1987	43,500,000.	2,500,000.
1988	43,500,000.	2,500,000.
1989	43,500,000.	2,500,000.
1990	43,500,000.	3,800,000.

Employment

Employment ratio estimates referred to in Chapter III (See Employment Section) are made available by county.* (Table B).

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* Estimates made available through the Coal Town II Model, Montana State University, Bozeman, Mont.

TABLE B
Estimated Employment/Population Ratios
(1978-1990)

Year	Big Horn Co.	Sheridan Co.
1978	.4250	.4619
1979	.4291	.4660
1980	.4345	.4668
1981	.4399	.4678
1982	.4425	.4676
1983	.4446	.4669
1984	.4463	.4661
1985	.4479	.4652
1986	.4478	.4628
1987	.4477	.4607
1988	.4475	.4585
1989	.4473	.4564
1990	.4303	.4374

Migration

Migration estimates are made available for the two county area between 1978 and 1990.

TABLE C
County Migration Estimates
1978-1990

Year	Big Horn County	Sheridan County
1978	134	514
1979	-71	230
1980	33	-132
1981	228	302
1982	111	205
1983	116	174
1984	127	184
1985	133	190
1986	174	267
1987	177	276
1988	181	272
1989	183	262
1990	688	1312

Price Index

In the Coal Town II Model the following price index is utilized for the model. This index expresses the degree of price change for the two county area between 1978 and 1990. (Table D)

TABLE D
Price Index
1978-1990

1978	1.6570
1979	1.7580
1980	1.8640
1981	1.9830
1982	2.1120
1983	2.2390
1984	2.3660
1985	2.4990
1986	2.6400
1987	2.7850
1988	2.9380
1989	3.1000
1990	3.2700

MONTANA HISTORICAL SOCIETY
225 NORTH ROBERTS STREET • (406) 449-2694 • HELENA, MONTANA 59601

July 12, 1978

Appendix N-1

Mr. Edwin Zaidlicz
State Director
Bureau of Land Management
Granite Tower
Billings, Montana 59101

RE: NERCO Spring Creek Mine
Cultural Resources Compliance

Dear Mr. Zaidlicz:

I have reviewed the letter dated October 17, 1977, from Robert A. Teegarden, District Manager, BLM, Miles City, Montana, to Doug Hileman, Area Mining Supervisor, USGS, Billings, Montana, and its applicability to Section 106 of the Historic Preservation Act. Although, for the most part, I agree with its contents, certain requirements have been omitted, and I have interjected them where appropriate. Also, in order to clarify a situation which has led to problems in the proposed Spring Creek project, I have added a few phrases. The view of this office is that the following will constitute compliance:

1. A 100% intensive survey for the identification of cultural resources will be completed in the entire EIS boundary and right-of-way access corridors, as required by Executive Order 11593. The survey will be conducted in accordance with BLM Manual 8111.14B for Class III intensive inventory (see attached). It is my understanding that all lands within the EIS boundary have received this intensive inventory except: W 1/2 W 1/2, SE 1/4 SW 1/4, Section 30, T. 8 S., R. 40 E.
   N 1/2 NE 1/4, Section 23, T. 8 S., R. 39 E.

   The entire inventory will be addressed in the EIS.

   Although State Lands guidelines recommend surveying of a one-mile buffer zone, this guideline was waived by State Lands because it was established following submittal of the Spring Creek Mining and Reclamation Plan.

2. Identify and address the cultural resources which potentially will be impacted as a result of the proposed Central Field Mine Plan. The area of concern includes the proposed permit area shown on Plate 13 (Bonding Permit Map-Spring Creek Coal Field, dated 4-12-78), BLM Coal Lease M-069782 and associated transportation corridors.

3. All sites identified in the impact area will be evaluated by complete field recording and/or testing to determine subsurface potential, and to determine if criteria are met for listing on the National Register of Historic Places. (The 23 sites in the Fox-Taylor 1977 report which do not meet the criteria do not require further consideration beyond the identification phase.)

   Although testing for buried deposits where no surface evidence exists is not a legal requirement, we concur with the recommendation of BLM to use this technique as a means of identifying sites which cannot be located by surface examination.

4. The Bureau of Land Management, in consultation with the State Historic Preservation Officer, will request a determination of eligibility from the Secretary of Interior for all sites which appear to meet the criteria for listing on the National Register of Historic Places. (35CFR 800.4 (a) (2), and 800.10).

   Presently, sixteen prehistoric sites have been determined eligible for listing on the National Register. These are: 24BH1583, 1589, 1591, 1593, 1595, 1597, 1602, 1614, 1610, 1606, 1609, 1045, 1618, 1046, 1619 and 1052. Five sites, 24BH1044, 1058, 1605, 1598, and 1584 require further testing to determine if criteria are met. Site 24BH1617 has been determined ineligible.

5. The BLM, in consultation with the State Historic Preservation Officer, will determine the effect of the proposed Central Field Mine Plan as described in Item 2 above on all cultural resources eligible for listing on the National Register of Historic Places (36CFR800.8). If effect is established, the criteria for adverse effect will be applied (36CFR800.9). The finding will be submitted to the Executive Director of the Advisory Council on Historic Preservation along with a preliminary case report (36CFR800.4 (2) (e) & (f).

6. If the effect is found to be adverse, the responsible federal agency will direct NERCO to prepare a research design for the mitigation of effect by a data recovery program or the avoidance of effect. This mitigation avoidance design plan may be submitted to various concerned state and federal agencies, and will be submitted to the State Historic Preservation Officer and the Executive director of the Advisory Council on Historic Preservation as a part of the required consultation process (36CFR800.5)

7. The BLM, State Historic Preservation Officer, and the Advisory Council on Historic Preservation will review the preliminary case report, the mitigation design and avoidance plan to consider alternatives of mitigation and avoidance. The three parties' decision will be in the form of a Memorandum of Agreement (36CFR800.5 and 800.6).

The above steps must be completed prior to the issuance of a mining permit or the implementation of any mitigation plan.

Mr. Edwin Zaidlicz July 12, 1978

8. The responsible federal agency may authorize NERCO to begin any mitigation approved in the Memorandum of Agreement. Mitigation by data recovery may be completed in stages so as to permit the timely execution of any approved project. All parties signatory to the Memorandum of Agreement must agree in writing that all mitigation in any particular area is complete prior to the disturbance of that area.

9. A final professional report on all inventories, mitigation design and plan, and data recovery will be submitted to this office and other appropriate state and federal agencies for review and comment.

The items discussed above were addressed during a meeting held in Helena on July 12, 1978. Those in attendance (list attached) included representatives of the U. S. Geological Survey, the Bureau of Land Management, the Department of State Lands, the State Historic Preservation Office, and Northern Energy Resources Company. All parties concurred with the procedures as outlined above.

Now, for a few general observations. We must remain objective in our quest for identification of project impacts to cultural resources. It is therefore, critical that an intensive inventory and testing be conducted prior to the implementation of any mitigation plan on known sites. Mitigation closes the door to any other alternatives; and, therefore, it is in violation with the purposes of the National and the Montana Environmental Policy Acts to begin excavation prior to the completion of the review process.

The identification of all impacts to cultural resources may change the direction of presently conceived mitigation plans. A well executed mitigation avoidance design plan should be applicable to all sites in this area in its overall research objections, not just previously recorded sites. This primary document can then specify exactly what form mitigation will take at each particular site. It can be amended as work progresses, if necessary, to meet changes in research needs. I see no need for two separate mitigation documents for recorded and yet to be identified sites.

If previously recorded sites are mitigated prior to the completion of the total inventory and implementation of the Advisory Council's procedures on all eligible and adversely effected sites, it may lead to confusion as to which areas have compliance, and where project implementation can begin.

Thank you for consulting with me in your planning stages. I would appreciate being kept up to date on your study by receiving any progress reports or interim reports that you may require. I would also be interested in reviewing the contract for the cultural resource inventory and testing, and the contractor's proposal.

Sincerely,

Ken Korte
State Historic Preservation Officer

KK:EV:rgh

cc: (see attached list)

.14 Class III - Intensive Field Inventory.

A. Objectives. The objective of a Class III inventory is to identify and record, from surface and exposed profile indications, all cultural resource sites within a specified and defined area. The Class III inventory results in a total inventory of cultural resource sites observable within a specified area. Upon completion of Class III inventories within a specified area, no further cultural resource inventory work will usually be needed. However, further cultural resource data studies may be carried out, as necessary. (See .14C4.)

B. Methodology. Define the area of the inventory accurately and clearly. Actual ground coverage results in the identification and recordation of all cultural resource sites observable from surface and exposed profile indications. Use the following guidelines:

1. Review the existing cultural resource site records prior to beginning actual ground coverage. Identify all recorded cultural resource sites within the area to be inventoried.

2. Locate, on the ground, the boundaries of the inventory area prior to beginning the inventory. Use corner markers, benchmarks, topographic maps, aerial photographs (where available), and other locational features and aids. This ensures ground control and proper location of cultural resource sites.

3. Cover the area to be inventoried on foot, utilizing adjacent sweeps. Spacing between crew members should not exceed 30 meters. However, spacing may be varied according to terrain, obtrusiveness, visibility, or other factors provided a valid rationale for intensity of coverage is presented. In all cases, coverage should be thorough, and continuity between sweeps must be maintained.

4. Record each cultural resource site identified (see .3).

C. Report Content and Format. For all Class III inventories, prepare a report commensurate with the project's size and the quality and quantity of cultural resources present. For small-scale projects involving minimal surface disturbance, or small project areas having no cultural resources, a brief summary document, with appropriate maps and site forms, which addresses the general categories outlined below, may be all that is necessary. For large-scale projects involving extensive surface disturbance and numerous cultural resources, a detailed report with extensive documentation may be required. All Class III reports should provide an appropriate level of data for the following categories of information:

ATTACHMENT: 2

ARCHAEOLOGICAL CLEARANCE MEETING
SPRING CREEK PROJECT - HELENA, MONTANA
JULY 12, 1978

NAME	TITLE	PHONE
Mike Eidlin	NERCO	503-243-4892
Dee C. Taylor	Anthropology, Univ. of M.	406-243-5921
Alan Carmichael	Anthropology, U. of M.	406-243-2693
Tom E. Roll	Anthropology, M.S.U. SHPO Consultant	406-994-4201
Edrie Vinson	State Historian, Preservation Office	406-449-2694
Sandi Johnson	DSL - Coordinator	406-449-2074
Ralph Driear	DSL - Environmental Admin.	406-449-2074
Jon M. White	U.S.G.S. OAMS, Billings	Com. 657-6181 FTS 585-6181
Stephen F. Lintner	U.S.G.S. Reston, VA	Com. (703) 860-6464 FTS 928-6464
Craig L. Howard	DSL - Coordinator	406-449-2074
Mike Arne	NERCO	503-243-4886
Bob Bennett	BLM, Miles City	232-4331
Jim Murkin	BLM, Miles City	232-4331
Margie Taylor	BLM, MT State Office	FTS 585-6474
Jerry Clark	BLM, Miles City	232-4331
Glenn Malmberg	U S.G.S., Billings	Com. 657-6678 FTS 585-6678
David Schleicher	U.S.G.S., Denver	Com. (303) 234-3960 FTS 234-3960

Appendix O.

The VRM rating system evaluates scenic quality, visual sensitivity levels and visual zones.

1) Scenery quality ratings are based on the presence of landforms, color, water, vegetation, uniqueness, and intrusions. After rating, the areas are grouped into Class A - 15-24 (Excellent), Class B - 10-14 (Good), or Class C - 1-9 (Average).
2) Visual sensitivity levels are an index (high, medium, or low) of the relative importance of the visual resource. In this case, the only criteria used was numbers of viewers.
3) Visual zones are areas that can be seen as foreground-middleground)3-5 miles from viewpoint), background (5-15 miles from viewpoint), or seldom seen (areas with little or no visibility or beyond the background zones.)

Landscape character elements (form, line, color, and texture) are described because they are the basic factors used to measure changes (or impacts) resulting from the proposed action.

Form - The mass or shape of an object. It is most strongly expressed in the shape of the land surface, usually the result of some type of erosion, but may also be reflected on the shape of the openings, changes in vegetation, or in the structures placed on the land.

Line - Abrupt contrast in form, texture, or color. Lines may be found as ridges, skylines, structures, changes in vegetative types, or individual trees and branches.

Color - Usually most prominent in the vegetation but may be expressed in the soil, rock, water, etc., and may vary with the time of day, year and the weather.

Texture- Result of the size, shape, and placement of parts, their uniformity, and the distance from which they are being obstrued. Texture is usually the result of the vegetation or vegetative patterns on the landscape. Texture may also be the result of the erosive patterns in rocks or soil.

These factors are combined to determine Visual Management classes for which suggested management objectives are prescribed (see Chart II___). These classes describe the degree of visual alteration that is acceptable according to Bureau of Land Management standards within the characteristic landscape. Class I privides the greatest amount

of pretection while Class IV allows for modification of the landscape character.

Class I (Preservation). This class provides primarily for natural ecological changes only. It is applied to primitive areas, some natural areas, and other similar situations where management activities are to be restricted.

Class II (Retention of the landscape character). Changes in any of the basic elements (form, line, color, or texture) caused by an acitvity should not be evident in the characteristic landscape.

Class III (Partial retention of the landscape character). Changes in any of the basic elements (form, line, color, or texture) caused by a management activity may be evident in the characteristic landscape. Hwoever, the changes should remain subordinate to the visual strength of the existing character.

Class IV (Modification of the landscape character). Changes may subordinate the original composition and character, but must reflect what could be a natural occurrence within the characteristic landscape.

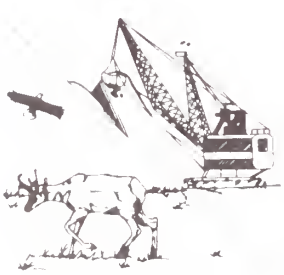
Class V (Rehabilitation of enhancement of the landscape). Applies to areas where the naturalistic character has been disturbed to a point where rehabilitation is needed to bring it back into character with the surrounding countryside. This class would apply to areas identified in the scenery evaluation where the quality class has been reduced because of unacceptable intrusions. It should be considered an interim short term classification until one of the other objectives can be reached through rehabilitation or enhancement. The desired visual quality objective should be identified.

Detecting contrast (or impacts) in the basic elements varies on a scale from 4 (form) to 1 (texture). Assigning values that indicate degree of contrast (3 for strong, 2 for moderate, and 1 for weak) allows a direct multiplier to be set up which will indicate the strength of the contrast. A score of 1-10 for each feature indicates that the contrast can be seen but does not attract attention; 11-20 attracts attention and begins to dominate the landscape; 21-30 demands attention and will not be overlooked. The total score is not as significant as the score for a single feature. The contrast ratings for the proposed mine are summarized in Table 3-1 & 2.

STATE OF MONTANA

DEPARTMENT OF STATE LANDS

MAILING ADDRESS: CAPITOL STATION
OFFICE: 1625 11TH AVENUE HELENA 59601 (406) 449-207



RETURN RECEIPT REQUESTED
Certified Mail No. __________

January 12, 1978

NERCo
P.O. Box 8451
Portland, OR 97207

Attention: Mike Arne

Re: Application for Permit #00050 for Spring Creek Project

Dear Mr. Arne,

The Department of State Lands has reviewed your application for permit #00050 received 8/1/77 and as revised by letters of 8/4/77, 8/9/77, 8/11/77, 8/25/77, 9/22/77, 10/3/77, 10/17/77, 11/10/77, 11/22/77, 11/28/77, 12/1/77, 12/2/77, 12/22/77, 12/22/77 and 12/27/77.

The application is deemed not complete at this time. Due to numerous revisions and the complexity of the application format further correspondence will be forthcoming as information is received from expertise concerning specific problems. As explained in my letter of 12/16/77, please follow your present system of complete replacement of pages and/or plates when making revisions or corrections.

NERCo's application must comply with the initial federal regulatory program as outlined in the final interim regulations dated December 13, 1977. Sections 715 and 716 must be compiled with. The Department of State Lands has not made a complete analysis of your application regarding compliance with these sections as clear copies of the final regulations have not been received to date. A letter will be forthcoming concerning compliance with the federal act.

The following general comments should be addressed with a positive commitment in the narrative of your application. Be as specific as possible in your response.

1. Materials which are not conducive to revegetation techniques, establishment, and growth shall not be left on the top or within eight feet of the top of regraded spoils or at the surface of any other affected areas. The department may require that problem materials be placed at a greater depth.

2. Box cut spoils or portions thereof, shall be hauled to the final cut if:

   a) excessively large areas of the mine perimeter will be disturbed by proposed methods for highwall reduction or regrading of box cut spoils, or

   b) material shortages in the area of the final highwall or spoil excesses in the area of the box cut are likely to preclude effective recontouring.

3. The department may require terracing to conserve moisture and control water erosion on all graded slopes during the process of current grading.

4. If the operation involves stripping and augering, the augering shall follow the stripping by not more than 60 days and final grading and backfilling shall follow the augering by not more than 15 days, but in no instance shall an area be left ungraded more than 1,500 feet behind the augering.

5. All backfilling and grading shall be completed within 90 days after the department has determined that the operation is completed or that a prolonged suspension of work in the area will occur.

6. In all cases the final pit shall be backfilled so as to cover all exposed coal seams with at least 4 feet of non-toxic fill material.

7. All mining activities, including highwall reduction, and related reclamation shall cease 100 feet from a property line, permanent structure, unmineable, steep, or precipitous terrain, or any area determined by the department to be of unique scenic, historical, cultural, or other unique value. If special values or problems are encountered by the department, it may modify buffer zone requirements.

8. The transition from undisturbed ground shall be blended with cut or fill to provide a smooth transition in topography.

9. Haul roads through permitted areas shall be allowed providing that their presence does not delay or prevent recontouring or revegetation on immediately adjacent spoils.

10. The department may require that access roads be graded, constructed, and maintained in accordance with the following requirements:

    a) no sustained grade shall exceed 8%,
    b) the maximum pitch grade shall not exceed 12% or 300 feet,
    c) there shall be no more than 300 feet of maximum pitch grade for each 1,000 feet,
    d) the grade on switchback curves shall be reduced to less than the approach grade and shall not be greater than 10%,
    e) cut slopes shall not be more than 2:1 in soils or 1/2:1 in rock,
    f) all grades referred to shall be subject to a tolerance of 2% of measurement. Linear measurements shall be subject to a tolerance of 10% of measurement.
    g) additional requirements may be imposed by the department if special drainage or steep terrain problems are likely to be encountered.

11. Drainage ditches shall be constructed on both sides of the through-cut, and the inside shoulder of a cut-fill section, with ditch relief cross drains being spaced according to grade. Water shall be intercepted before reaching a switchback or large fill, and shall be drained off or released below the fill. Drainage structures shall be constructed in order to cross a stream channel, and shall not affect the flow or sediment load of the stream.

12. All cut and fill slopes resulting from construction of access roads, railroad loop, or haul roads outside of the area to be mined shall be stabilized, and revegetated the first seasonal opportunity.

13. Upon abandonment of any road or railroad loop, the area shall be conditioned and seeded and adequate measures taken to prevent erosion by means of culverts, water bars, or other devices. Such devices shall be abandoned in accordance with all provisions of Chapter 325, Session Laws of Montana, 1973, and MAC 26-2.10 (10)S-10330 and MAC 26.210(10)-S10340 of the Rules and Regulations adopted pursuant thereto. Upon completion of mining and reclamation activities all roads shall be closed and reclaimed unless the landowner requests in writing and the department concurs that certain roads of specified portions thereof are to be left open for future use.

14. Please address all points in the Rules and Regulations regarding blasting, in narrative form and agree to comply with every requirement.

15. Stockpiles of salvaged topsoil shall be located in an area where they will not be disturbed by ongoing mining operations and will not be lost to wind erosion or surface runoff. All unnecessary compactions and contamination of the stockpiles shall be eliminated and once stockpiled the topsoil shall not be rehandled until replaced on regraded disturbances.

16. In the case of abandoned roads, the roadbeds shall be ripped, disced, or otherwise conditioned before toposil is replaced the department may prescribe additional alternate conditioning methods for the reclamation of abandoned roadbeds.

17. If necessary, redistributed topsoil shall be reconditioned by discing, ripping or other appropriate methods. Gypsum, lime, fertilizer, or other amendments may be added in accordance with MAC 26-2.10(10)S-10350, and/or as stated in the approved reclamation plan.

18. The operator shall take all measures necessary to assure the stability of topsoil on graded spoil slopes.

19. Any application for permit or accompanying reclamation plan which for any reason proposes to use materials other than or along with topsoil for final surfacing of spoil or other disturbances shall document problems of topsoil quantity or quality. The application or plan must also show that the topsoil substitute proposed:

    a) will not contribute to or cause pollution of surface or underground waters.
    b) will support a diverse cover of predominately native perennial species equivalent to that existing on the site prior to any mining related disturbance.

20. The assignment of BLM Coal Lease Montana - 069782 from PP&L to Spring Creek Coal Company must be completed before a permit will be issued.

21. The proof of publication section, described on pages 12 and 13 of volume 1 of the application for surface mining permit, is not acceptable as the actual "proof of publication" notice from the newspaper must be received by this Department.

22. Subsidence potential after mining may pose serious problems with respect to; 1) reestablished stream gradients which will be quite gradual, and 2) to the separation of the 2 forks of Spring Creek which appear to have very little in the way of a topographic barrier between them after mining. The problem of subsidence has not been addressed by Spring Creek Coal Company in its application.

23. Page 21 the last two paragraphs. There is a 44 millon ton difference between the strippable and the recoverable figures. Where is all of this coal (15%) being lost?

24. On page 33 of the application it is stated that 4 feet of topsoil will be placed back into the reestablished floodplains of Spring Creek. The questions and comments that arise are: 1) Is 4 feet adequate to reestablish an alluvial aquifer? 2) The topsoil to be placed back into the channels should probably be the alluvium that was there in the first place. This would mean discrete salvage of the texture of soils to place back into the channels is required in any attempt to reestablish and stabilize an alluvial situation. 3) The channel slopes are proposed to be at a slope of 2:1. Although those would be very short slopes, the change in slope from the rest of the regraded mine area into the channels is quite abrupt. We may have trouble stabilizing them.

25. On page 32 of the application specifications of the settling ponds are given. One thing that was not specifically mentioned by the company was the placement of clinker at the discharge points of the outlet pipes which are connected to the decanting towers. This should be done.

26. Page 39 - any modification of the grain drill making it more suitable for reclamation purposes must be discussed. Superior results have been obtained by Decker utilizing "Brillion" cultipacker.

27. Page 42 - The cover crop to be used should be specified and seeding rates included. If millet is to be used the suitability of millet should be referenced.

28. Page 45 - while mulching prior to seeding to prevent wind erosion is desirable, drill seeding could effectively disrupt the effectiveness of the mulch. Since there is a limit to the organic material which can be decomposed by soil microrganisms, only one mulch application is advisable. It would seem logical to apply mulch after seeding. The mulch would then prevent erosion of the soil covering the seed, and maintain soil moisture, while adding organic matter to the soil. The planting sequence should be reworked to obtain one mulch application after seeding.

29. In the analysis of regraded and retopsoiled spoils areas referred to on page 45, analysis of NH_4^+ -N should be added to topsoil analysis; the anlyses of gypsum requirement can be deleted from the spoils analysis. At least part of the fertilizer should be applied at the time of seeding, not exclusively during the second growing season as the company proposes.

30. On page 54, Spring Creek Coal Company has indicated that it may use a chemical dust suppressant. Prior to the use of such a material, the company should inform us as to what the chemical is, what its composition is, and should obtain departmental approval. Commit to this procedure in your application.

31. Page 82 - The representative characteristics (BTU's, ash, sulphur, etc.) of the Canyon seam are not presented. Federal 211 Regs ask for this information.

32. On page 85, and 86, the company lists provisions of 3Q CFR 211 regulations which it must comply with under the cooperative agreement between the Department of State Lands and the Feds. If the company desires variances from these requirements (which relate to the sampling of overburden) it should obtain a letter from the U.S. Geological Survey authorizing such variances. A copy of this letter should be sent to us.

33. The letter referenced under III, B page 86 is not acceptable as the letter specifically addresses the question of an "exploration permit", not a mining permit.

34. On page 111, under (ii), how eill Spring Creek Coal Company go about "limiting the size, timing, and frequency blasts as determined by the physical conditions of the site?" This is an important consideration from the standpoint of air quality impacts, since blasting can create substantial dust problems. In addition, blasting can have an effect on aquifers outside the permit boundary.

35. The Department of State Lands is adopting a policy of 5:1 highwalls as the maximum allowable slope on reclaimed area. Problems with stabilization of 3:1 slopes have necessitated this change. On page 112 no slopes should be steeper than 5:1.

36. On page 113 in the response of Spring Creek Coal Company to "F", the words "whenever practicable" should be deleted.

36. Page 114 - The next to the last paragraph should read ". . . prepare the soil and plant such legumes, grasses, shrubs, and trees . . ."

The following comments are specific to vegetation.

There are two remaining inadequacies in the baseline vegetation work which must be addressed.

1. The calculation of the range condition and carrying capacity is presently unacceptable. The Department of State Lands has talked to Paul Higgins about this problem, and he has assured the Department that a new section is forth coming.

2. If any of the areas described as weed community are presently being managed agriculturally (as pasture improved range or hay field which would qualify under the federal law) these areas should be indicated. If possible an agricultural history should be presented for the cultivated areas. Period of cultivation, approximate date of abandonment, crops raised, etc.

Page 48, Table 5 - There are two overriding problems with all of the mixtures proposed in the Spring Creek application:

1. The mistures are too specific. In attempting to design mixtures for specific sites they have in many cases designed them for specific soils. What the soils will be after mining is an unknown. While specific mixtures should be designed for stream courses and highwall reductions. A "broad brush" type mixture would be better suited for the majority of the area. This means a mixture with sufficient diversity to develop communities on the different microsites encountered on the regraded area.

2. The mixtures contain no legumes. Legumes would help build the soil after mining.

Page 48, Table 5 Area #1 - The misture is essentially acceptable, however more shrubs, in particular skunkbush sumac should be added.

Page 48, Table 5 Area #2 - More grasses should be added. Antelope bitterbrush is not found in this area and should be relegated to an experimental status. The misture should include shrubs such as rose, snowberry, and possibly chokecherry (these species would likely have to be planted as seedlings or transplants).

Page 49, Table 5 Area #3 - This misture lacks diversity, and while it may be suited for floodplains, is not suited for stream channels. A more diverse mixture should be devised for the floodplain, or a general purpose mixture should be used. The stream channel should include strongly rhizomatous species and mesic species. Basin wildrye occurred there naturally and should be included. Other trees and shrubs should be included for the sites too mesic for silver sagebrush. An effort should be made to replace the cottonwoods.

Page 49, and 50. Table 5 Areas #4, 5, and 6. The mixtures for areas 4, 5, and 6 should be combined for a single "broad brush" mixture. The area 4 mixture appears to be designed for heavy textured soils. The cool season, warm season breakdown for areas 5 and 6 are not valid. Spring Creek should strive to find a diverse mixture which would establish a suitable cover for the whole area. Modifications should then be made for specific sites. The idea of selected corridors for wildlife is unacceptable. Wildlife habitat should be spread throughout the area.

Page 51 - paragraph (7) Spring Creek should specify mulching of all disturbed areas, except where cover crops are established as approved by the Department pursuant to the federal rules.

Previous reclamation experiences have indicated little success with establishing species such as Ponderosa Pine, skunkbush sumac, and other tree and shrub species by seed. Spring Creek should commit to using seedlings and/or transplants to reestablish tree and shrub species.

The problems of habitat reestablishment of tree and shrub species on reclaimed land will probably be the greatest reclamation problem to be faced. Intensive efforts in planning are needed now to provide suitable techniques seed sources to solve the problem. The idea of utilizing a tree spade to transplant trees and shrubs from areas to be disturbed shows great promise and should be investigated. Similarly the concept of sodding dense rooted grass species from bottom lands and using the mat to stabilize recently reclaimed potential problem areas should be seriously considered.

During the review of the wildlife baseline study, prepared by VTN, we have noted the following deficiencies which require greater elaboration to adequately assess the wildlife portion of the permit application pursuant to 50-1042 RCM 1947 and 26-2.10(10)-S10300(c) A.R.M.

1. There was no listing of the biologists participating in the study. Such a listing and their qualifications are necessary to assess Sections 50-1042 RCM 1947 and 26-2.10(10)-S10300(c) A.R.M.

2. The description of the wildlife habitat types is in apparent conflict with the results of the vegetation survey. Of particular concern is the breakdown of the sagebrush vs. sagebrush/grassland types. The sagebrush type is composed of one vegetation community while the sagebrush/grassland type is composed of five vegetation communities. All of the vegetation communities encompassed by these two wildlife habitat types are physiognomically similar, thereby, skewing the relative importance of the sagebrush/grassland type. Further, the incorporation of shrub species other than sagebrush (eg. *Rhus trilobata*) into the sagebrush/grassland habitat obscures the importance of such shrubs to wildlife (Section 50-1042(2)(a) RCM 1947).

3. The Chiroptera need more work. The bat collections were very random. Collections and species identifications should include sex of each species, condition of the species (i.e. lactating female, etc.), date of the collection and location of the collection. Attention should be focused on the Montana Department of Fish and Games listing of species of special interest (Section 50-1042(2)(c) RCM 1947 and 26-2.10(10)S10300(c)(i) A.R.M.).

4. The Peregrine falcon is an endangered species and was observed on the study area. Also, VTN made reference to the spotted-bat, a threatened species. More discussion is needed on this species (26-2.10(10)S10300(c)(i) A.R.M.).

5. The map showing the active and inactive raptor nesting locations should be revised to include the locations of the prairie falcon nests referenced in the baseline text (26-2.10(20)-S10300(c)(i) A.R.M.).

6. The method of calculating small mammal densities was not referenced and should be. Also, the dates and times that aerial flights were made to estimate ungulate population densities should be submitted (26-2.10 (10)-S10300(c)(ii) A.R.M.).

7. Seasonal use of the study area by wildlife, particularly mule deer and pronghorn antelope, can not be interpreted from the maps. Maps should be revised to indicate season of use of the "major use areas" delineated on the ungulate maps. The discussion in the text should shed further light on this subject and discuss where the deer and pronghorn migrating into the area were previously distributed.

A wildlife habitat type map should be prepared and accompanied by mylar overlays of monthly sightings of mule deer, pronghorn antelope, and the gallinaceous birds. Such maps would be most beneficial if they were produced at a scale of 1"-1000'.

There was no discussion concerning fawning areas or nesting and brooding areas.

Such information is necessary to evaluate sections 50-1042(2)(c) RCM 1947 and 26-2.10(10)-S10300(c)(iii) A.R.M.

Generally the wildlife section lacked discussion and recommendations of the biologists who worked on the project. Probable impacts of the various phases of the mining operation should be discussed in detail by the biologist conducting the study. The project biologists should also discuss specific reclamation techniques to be incorporated into the reclamation plan to provide successful reclamation regarding wildlife species reestablishment.

The project biologists should give complete summaries of data and their interpretations. The wildlife data shows the Spring Creek may be a wintering ground for sage grouse, antelope and mule deer. Complete discussions of winter concentration areas are required. The presence of winter concentration areas may pose a special problem as the Department of State Lands cannot approve a permit containing items found under Section 9, (2)(a)(b)(c). The presence of winter concentration areas may involve considerations of items a, b and c. This problem should be directly addressed by Spring Creek.

Another problem to be addressed will be reclamation to provide a similar habitat which existed before mining for wildlife species. Under section 12 (a) in the act, the reclaimed vegetative cover must be capable of "feeding and withstanding grazing pressure from a quantity and mixture of wildlife and livestock at least comparable to that which the land could have sustained prior to the operation."

The presence of dancing and strutting ground as well as winter concentration areas may require further indepth radio telemetry to discern animal habitat needs and seasonal migration routes.

The presence of various raptor nests on the Spring Creek site will probably involve obtaining special permits under the Migrator Bird Treaty Act. Numerous other birds are also covered under this act.

The following discussion considers the adequacy of hydrological information submitted in the Spring Creek Application.

1. As specified under 26-2.16(10)S10300(2)(e)(ii), "The report shall include . . . a description of alternative water supplies to be undisturbed by mining that could be developed to replace water supplies diminished in quality or quantity by mining activities." NERCo has not supplied this information to date.

   In a letter to Rick Kent dated 6-1-77 the following information was requested:

   "State personnel expressed a need to monitor the next lower aquifer zone below the coal to observe changes that may take place in this zone as a result of mining and to identify an alternate water supply for the impacted area. NERCo agreed to run a pump test on well number 372 to determine if there is a sufficient quantity of water to serve as an aquifer and to sample the quality of water as well. Consideration should be given to the potential for this zone to mix with the lower quality waters that will occur at the base of the pit after mining. The state is not optimistic that the interburden between the Anderson Dietz and the Canyon can be proven an aquifer, nor that it will be hydrologically isolated enough from lower quality, post-mining ground waters to allow it to be used as a quality alternate water supply."

Based on the information from this study a final evaluation would be made of the alternate water supply, that would be unaffected by mining, to be used to support the post-mining land use. There is a possibility that additional data will be necessary to adequately determine what zone will be hydrologically separated from mining related impacts and yet provide a sufficient quantity of water for the intended land use.

In addition, a letter written to Rick Kent on 7-577 requested that; additional monitor wells be installed, single well recovery tests be conducted, water quality samples be collected and water levels be recorded. This material has not been received.

2. The Department does not agree with NERCo's plan to divert drainage from the scoria pit to a drainage south of the original direction of flow. The coulee currently receiving drainage from the area should receive the post-mining runoff from the area and the settling facility should be located in the same coulee.

   The final contours for the scoria pit should also be more smoothly blended with the existing topography.

3. NERCo predicts that 106,000 gallons per day will be intercepted in the pit. The Department would like to know how this number was developed.

4. Tributary drainages to Spring Creek and South Fork Spring Creek that are peripheral to the mine do not enter the reclamation area at an acceptable grade.

   a) Coulees entering the Spring Creek mine from the south bluff area drop too abruptly over the highwall reduction area.
   b) The tributary to South Fork Spring Creek on the west end of the mine is too steep just after entering the lease boundary.
   c) The major tributary to Spring Creek at the west end of the lease boundary drops too abruptly into the reclaimed area.

5. Concerning the major drainages of South Fork Spring Creek and Spring Creek.

   a) The post-mining recontoured surface map does not clearly show how reconstructed Spring Creek will be separated from the original Spring Creek channel in Section 24 BCD.

b) The gradients of both Spring Creek and South Fork reconstruction are sporadic.

1. The gradient of South Fork is too steep where the drainage enters the lease boundary and from that point the gradient randomly flattens and steepens along the stream passage through the mine area.

2. Similarly the gradient of Spring Creek randomly flattens and steepens along the course through the disturbance.

c) The Department would like the rationale used by NERCo to arrive at the meander frequency, amplitude and radius of curvature for the reclaimed South Fork and Spring Creek channels.

d) The Department does not agree with the Manning's N of 0.045 selected for the reclaimed channels of Spring Creek and South Fork. According to the E.P.A. publication "Erosion and Sediment Control Surface Mining in the Eastern U.S." vol. 2 p. 39, for a natural channel not completely lined with vegetation, a Manning's N of .025 is appropriate. NERCo can not assume that a dense mat of grasses can be established that would allow design according to the specifications for a grassed waterway. The E.P.A. publication continues, for natural channels not completely lined with vegetation in a clay loam a maximum non-erodable velocity of 4.0 feet per second is allowable. Although the objective is not to design a non-erodable channel, but rather a channel as stable as the natural drainage, a velocity well over 4 feet per second, can be expected when the correct N value is used. Such high velocities are critical. The Department would compromise on a velocity of 5 feet per second maximum velocity for the predicted 100 year storm.

e) The statement on page 27 of the Mining Permit Application, paragraph 1 that, "The peak flows are the result of rain-storm runoff." is not correct. On page 118 of the Mining Permit Application the data indicate the maximum storm on record for Spring Creek occurred February 14, 1971. A check of rainfall records indicated that no significant rainfall event occurred on that date. Therefore it is safe to conclude that the runoff event was a result of snow melt and possibly influenced by a light rain or frozen soils. The Department therefore cautions NERCo that floods can be expected at times other than the spring thunderstorm period.

f) New Federal Regulations recently published pursuant to the Surface Mining Control and Reclamation Act of 1977 state that, (715.15(J) Mining operations conducted in or adjacent to alluvial valley floors shall be planned . . . to preserve the essential hydrologic functions." The recognized subirrigated area on South Fork Spring Creek appears to fit under these provisions and should be addressed accordingly.

g) The Department does not approve of the proposed excavation impoundments on Spring Creek and South Fork for the following reasons.

    1. In order to evaluate the stability of the reclaimed channels a free flowing waterway must be maintained.

    2. The excavation will cause a locally steepened portion in the stream gradient which could initiate a head cutting sequence.

    3. Impoundments of this nature would induce unwanted leaching of spoil materials which would continue to lower groundwater quality.

In summary the Department would like to see all drainages blended with the reclamation topography with a smooth concave longitudinal profile. Flood predictions should be calculated for all drainages under the conditions of a 100 year storm and velocities should be calculated using the appropriate N of .03 which is widely used and accepted in the state. A maximum velocity of 5 feet per second should be reached during the 100 year storm.

6. The Department has the following comments on the diversion ditches associated with the Spring Creek Mine:

a) Under the conditions of a 50 year flood, the maximum design of the ditches, velocities are excessively high. The upper reaches for both diversions develop velocities over 7 feet per second which will surely scour out the scoria lining. A velocity of 5 feet per second should be the maximum velocity under the maximum design conditions. Velocities on the lower cascading stretches appear excessive also. On Spring Creek a velocity of 17 feet per second exists under the conditions of a 50 year flood. Although these ditches are in scoria it is doubtful if the fractured clinker could withstand such velocities. The Department has observed severe erosion in scoria bedrock and suggests that velocities be kept below 6 feet per second.

b) The concept of using two different gradients along the ditch demands that additional channel protection is needed where the channel breaks into the steeper gradient in order to prevent headcutting. Similarly the channel reach below the cascading portion must be protected with an apron in order to prevent accelerated erosion in the natural channel.

c) The Manning's N selected for the scoria channel is somewhat suspect. In Chow's book on Open Channel Hydraulics (1959), p. 120 a canal with large-cobblestone bed is assigned a N of .03. The E.P.A. Erosion and Sediment Control publication vol. 2, p. 42, calls for a lined channel with a median riprap size of approximately 15 inches for an N of .04. Due to the brittle fracturing nature of scoria it is doubtful that a 15 inch median riprap size can be achieved. The Department therefore asks that NERCo reassess the design of the diversion ditches using an N of .03.

7. The Department requests the geologic source of water from wells intended for mine personnel use.

8. The reclamation of the building area, railroad loop and bank-roads outside the lease boundary should be specified in narrative and depicted on the post-mining contour map.

9. Impounding structures should be excavated to remove accumulated sediments when they reach 5 percent of the storage volume of the structure as recommended by the Bureau of Reclamation in Design of Small Dams. The 5 percent volume should be staked in the field so personnel can readily observe when dredging is required.

10. The Department requests that NERCo establish flumes on the ditch or stream reaches that will receive pumped waters from the pit and that an accurate record be kept of pit water used in the mine. The purpose of this request is to check predictions of water interception in the pit. Hopefully if good records are kept, prediction techniques can gradually be improved.

11. The Department requests that NERCo plan the water supply for the post-mining land use and commit to drilling a specified number of wells. The well location, power source, geologic source, water quality and pumping rate should be given with information relating the well location to the post-mining management scheme.

12. Water quality analyses for the surface water is largely unacceptable. The difference between cation anion balance should not exceed 5 percent. This information will have to be recollected.

13. The Department requests that NERCo respond to the enclosed comments provided by Mr. Fred Shewman of the State's Water Quality Bureau.

In reviewing the archaeological baseline report submitted by NERCo, some deficiencies have been noted. These deficiencies were discussed with representatives of NERCo during a meeting held in Sheridan on October 15, 1977. In view of the complexity of the archaeological situation in the Spring Creek area, several years may be required to accomplish all of the work necessary to adequately address the archaeological resources in this area. A complete application could be attained in the near future, however, if certain criteria are met. The following is a listing of those critieria which were previously discussed with NERCo.

1. Complete an intensive surface survey of the following tracts using the Fox (1977) research desing:

   S½, NW¼, Sec. 23, T. 8 S., R. 39 E.
   SE¼ NE¼, Sec. 22, T. 8 S., R. 39 E.
   S½ N½, Sec. 27, T. 8 S., R. 39 E.
   SE¼, Sec. 27, T. 8 S., R. 39 E.
   SW¼, Sec. 26, T. 8 S., R. 39 E.
   W½ SE¼, Sec. 26, T. 8 S., R. 39 E.

2. Reinventory, test, and mitigate by data recovery the sites recorded by Lahren (1977) using the Fox (1977) research design. Data recovery at this stage should be confined to controlled surface collection. Sites requiring excavation as a mitigating measure should be treated under Step 5.

3. Prepare a research design for the data recovery program on all the sites recommended for the National Register of Historic Places in the Fox report (1977). Submit copies of the research design to the Montana Department of State Lands, the Montana State Historic Preservation Officer and the Miles City District of the Bureau of Land Management through the USGS Area Mining Supervisor for review. Upon approval of the research design by these agencies, the BLM will prepare documents to comply with Section 106 of Public Law 89-665 and submit the recommended treatment of the National Register potential sites for Advisory Council Comment.

4. Initiate a program to discover possible buried cultural deposits where no surface cultural material is visible. In alluvial areas near drainage bottom and on some lower terraces, backhoe trenching or other tests will be undertaken to search for buried cultural sites. The cultural resource contractor may use a probability sampling model or other approach to do the testing but, techniques will be made explicit in reports. If these tests yield high site densitites, the program may be expanded as recommended by the contracting cultural resource personnel.

5. As a separate part of the data recovery proposal submitted in Step 3 or as another document, prepare a research design for sites requiring excavation found as a result of activities performed in Steps 1, 2, and 4. Submit this document for agency review as outlined in Step 3.

6. Begin data recovery (excavation) of sites addressed in Step 5 when reviewing agencies approve the research design.

7. Begin data recovery of sites addressed in Step 3 when Advisory Council Comment is taken into account by the Montana SHPO and BLM.

These criteria should be immediately applied to those sites contained within the area of the 5-year permit which would suffer surface disturbance. A written agreement should be received indication that these criteria would also be applied to all other sites encompassed by the life-of-mine disturbance area in advance of such disturbance.

NERCo's contracting cultural resource personnel are responsible for preparing professional monographs which address the results of all survey, testing, and excavation phases of the outlined project. The reports must synthesize all data collected to address hypotheses stated in the designs. The draft reports will be submitted to the agencies outlined in Step 3 for approval. Agencies have 30 days to respond on report adequacy.

The archaeological survey is not complete at this time.

Last fall, Scott Fisher, soil scientist with the State Northern Powder River EIS Team and Clinton Mogen, retired soil scientist with the S.C.S., conducted some field checks of the soils survey work at Spring Creek. Their work raised some serious questions with regard to the adequacy of soils information received as part of the Spring Creek permit application. Generally speaking, their work indicated that many soil types included within various VTN delineations were not described or mapped and that some mapping units needed refinement, redefinition,

or remapping of boundaries. Discussions with Scott Fisher indicate that the level of mapping done on the Spring Creek project do not meet the minimum acreage requirement of our guidelines which Spring Creek Coal Company agreed to do before the soil survey was initiated and which Spring Creek alludes to in the application.

On a more detailed level, two areas of soil represented by Arvada, Bond, and Hydro series were found by Fisher and Mogen but were not mapped or described by VTN. These soils have undesireable physical and chemical properties and are thus to be avoided in salvage operations, and since in at least one of the two areas they make up an area 20-40 acres in size at Spring Creek, this is a serious omission.

Another problem relates to the lack of detailed descriptive analytical information on map unit #2 designated as Alluvial lands, loamy which appears to have some significant accumulations (up to several feet) of suitable topsoil but which was given a salvage depth of only 20" in the application. It would appear that much work is required on this unit in order to adequately delineate the various soils for salvage and to give the operator a reasonable guide in salvage operations. The same considerations probably apply also to map unit #10 - Terrace Edges and Escarpments, loamy, steep and very steep.

Enclosed find Fisher's and Mogen's observations and comments along with our own for response by Spring Creek Coal Company.

Following are my detailed comments on the specific soils information that was provided by Spring Creek Coal Company.

1. In several instances in the descriptions of mapping units, references were made to soil types that were designated as inclusions and which raised questions about whether these inclusions should be mapped. For example, on page 9, under Colbar, silty clay loam, 1% to 4% slopes, the last sentence indicates that in this mapping unit near scoria beds "deep red loams or silt loam soils and Erlan loams of up to 2 acres occur." If this is the case, it appears as if at least the Erlan loams should have been mapped. If the other soils were highly contrasting with the Colbar, they also should have been mapped. Another example occurs on page 11 where, under Corkim loam (1-4% slopes) is stated "some areas of red soils are included." What are these red soils? Are they high contrasting or low contrasting soils compared to Corkim loam? should they have been mapped? Similar additional questions concerning inclusions are found in Erlan slightly slatey loam, 2 to 6% slopes (page 13), Shale outcrop (page 15); Shinler soils, hilly (page 17); Sperlin loam, undulating (page 19); and Sperlin - Wiberg rocky loams, rolling (page 20).

2. What company conducted the analysis of the soil samples?

3. I found 23 soil samples that were given incorrect textural designations based upon the particle size analysis. All but two of these were clay loams. The other two were silty clay loams. Apparently, the computer stuck when it got to clay loams.

4. The metes and bounds locations of the following soil samples did not match their locations on the soils maps: 1, 2, 7, 10, 11, and 12. Samples sites 14 and 17 were not located on the 1" = 400' soils maps nor was site 14 located on the 1" = 1000' map.

5. On page 43 of the application is given salvage depths of the various soil series and mapping units.

   a) The first problem that is evident with this list is that 4 mapping units are not included: Erlan slightly slaty loam, 2-6% slopes (mapping unit 3), Sperlin - Wiberg loam, undulation (8); Sperlin loam, undulating (13); Shinler - Rock outcrop, very steep (29).

   b) Another problem involves the use of single soil sampling locations to establish the salvage depths of Colbar silty clay loam, 1-4% slopes (mapping unit 1) in three general areas where it is located. This soil series on the project area tends to be quite saline at variable depths in the C horizon. Thus salvage depths of this unit will have to be based on considerably more sampling.

   c) On what basis was 96" established as a salvage depth for Corkim loam and Terrace Escarpments?

   d) The salvage depths of units 6 and 6X (Kimlen - Colbar - Shinler, 5-10% slopes, and Kimlen - Colbar - Shinler, dissected, 5-10% slopes) were based analytically on two samples (10 and 14) of one of the dominant series - Kimlen. This is a very inadequate basis on which to make such a recommendation.

   d) There is a difference in the salvage depth of Shinler soils, hilly (4") and the Shinler Component of Shinler - Wiberg soils, hilly (10") which I do not understand.

   e) The salvage depth of Colbar - Kimlen clay loams (1-4% slopes) (mapping unit 11) is based analytically on one sampling of Colbar series (sample number 13) which is hardly adequate for such a widespread unit.

f) In the case of soil complexes, Spring Creek Coal Company has in some cases estimated topsoil volume based upon a single salvage depth of all series found in the complex. In other cases the complexes are broken down into their component series and salvage depths of each series are listed. What is the reason for these differences?

g) Does Spring Creek Coal Company propose to salvage topsoil consistent with their salvage depth estimated on page 43?

h) The Travella - Shinler complex is given the mapping symbol 17 in the text but 19 on the soils maps.

6. Spring Creek Coal Company should formulate a two lift salvage operation of topsoiling material. The A and sometimes B horizons should be salvaged separately from underlying C horizons. Characteristics of concern in this regard are more favorable organic matter, biological activity, and nutrient levels and lower lime contents in surface horizons as compared with subsurface horizons. The high Mg: Ca ratios as found in the water saturation extracts in subsurface horizons are also of some concern from a nutritional standpoint. Thus, gross maintenance of the intergrity of surface and subsurface topsoiling materials is desireable.

7. On page 41 of the application are listed the soil criteria by which salvage depths were determined. The cutoff for conductivity was 8.5 mmhos/cm which seems too high to me.

8. There are numerous errors on the soils maps the most common of which was 2 symbols occurring in the same delineation.

Everything considered, it appears as if the current soils survey information is an inadequate basis on which to evaluate the distribution and nature of the various soil types found at Spring Creek and to formulate an intelligent topsoil salvage plan.

There are substantial potential problems with the overburden that Spring Creek Coal Company needs to specifically address.

1. Substantial salt contents occur in the upper 10-30 feet of overburden. The almost invariable occurrence of this condition in the surface strata raises the question as to whether contamination of surface samples may be involved. Thus the department requests the original driller's logs and any other pertinent information relative to the means by which the holes were drilled and the samples taken. If the salt contents are, in fact, accurate representations of this parameter, the company will have to show how it intends to place the material so that it will not be within 8 feet of the post-mining surface and not in contact with post-mining groundwater.

2. Substational NO_3^- concentrations also occur in the surface strata of a number of holes. Again, if these are accurate representations of the NO_3^- contents in these strata, Spring Coal Company must show how it will keep this material out of contact with post-mining groundwater.

3. The majority of holes show sodic conditions (measured by both SAR and ESP) in all but the surface strata. How does Spring Creek Coal Company propose to keep this material below 8 feet of the reclaimed surface?

4. Other parameters of concern include the extremely high extractable iron contents in subsurface strata. The precise effects of these concentrations are not known in terms of plant nutrition if this material ends up in the plant rooting zone. Nickel and molybdenum also appear to occur in elevated concentrations, although the high iron contents might be expected to mitigate any problems with regard to these elements. These questions require further evaluation by the department and Spring Creek Coal Company.

5. The department will continue its evaluation of the overburden data with respect to the proposed mining plan and the federal act.

The air quality section will need further evaluation by the Health Department. The Department of State Lands with assistance of the Health Department will propose an expanded monitoring system for implementation during various project development phases.

A discussion of feasibility concerning mining of the Canyon coal seam is necessary in order for the Department of State Lands to evaluate your mining plan under the Coal Conservation Act. Items of concern include economics, equipment capability, reclaimed topography, special handling of toxic material and any other factor related to mining the Canyon seam.

There seems to be a discrepancy between the coal recovery rate stated on page 79 and that discussed on page 21. This problem should be cleared up.

The regraded contour map supplied with the application is too small to properly evaluate regraded contours. The Department requests a map of the scale of 1:400 showing regraded contour of your mine. The reclamation of facilities and scoria pit should also be shown on the regraded contour map.

The present map shows highwall reduction outside of the area to be mined. Backslopes out of the area to be mined should be eliminated where stability allows. Backfilling of the highwall areas is the accepted method of highwall reduction. The backfilling procedure reduces disturbed area, reduces the length of slope thereby decreasing erosion, and, since the steep bluff areas usually contain stands of trees and shrubs, these areas are usually better left untouched.

The encroachment of the mining operation on the steep and precipitous terrain poses a reclamation problem where ever it occurs. The steep slope terrain and its associated vegetation have been extremely difficult if not impossible to reestablish to date. Under section 26-2.10(10)-S10310 Mining and Reclamation Plan, (3) Buffer Zones, (a), the procedure when encountering steep and precipitous terrain is stated and should be followed.

Plate 13 from volume 2 entitled, "State Mine Plan, Bonding - Permit Map" shows associated disturbance in various areas outside of the coal lease area. The Department of State Lands does not wish to permit more area than is absolutely necessary for the mining operation. It does not appear that large areas to the South, West and North are necessary to conduct the mining operation. These areas contain steep and precipitous terrain and problems with any disturbance in these areas are great. All unnecessary area, especially that which contains steep slopes should be deleted from the permit application.

As you can see the review of your application was quite lengthy and involved numerous points which must be addressed. I suggest a meeting with the Department of State Lands staff after you thoroughly review the critique and application. Misunderstandings and corrections can be cleared up at such a meeting. After a meeting concerning the critique the appropriate corrections can be made.

Bear in mind that some problems may involve further research before a final decision can be made concerning your permit application.

The staff will complete their evaluation of the whole application for changes necessary under the Federal Strip Mining Act in the near future.

Sincerely,

Richard L. Juntunen
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